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Pressure Treated Wood in Canada: Task Force Report

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Abstract: At a Ministry of Transportation (MTO) forum on wood and preservatives, held in 1990, it became apparent that environmental issues, including worker safety, surrounding the use of wood preservatives were becoming very prominent. Increased public awareness, coupled with moves by most regulatory bodies to tighten restrictions on the use of toxic substances, such as preservatives, emphasized the need to evaluate preservative treated wood as it might affect people and the environment.

MTO formed a larger task force which included several federal regulatory agencies, and held an inaugural meeting, in Toronto, on February 19 and 20, 1991. At this meeting a two stage objective was established. The overall objective of the group was "to assist in the evaluation of the use of heavy duty wood preservatives and their effects on health, safety and the environment;" the interim, or short term objective, was "to collect and summarize the available literature and identify current activities relating to health, safety and the environment with respect to the use of heavy duty wood preservatives."

This report presents the results of four working groups which were formed from the task force, each dealing with a specific area: 1) Health and Safety, 2) Insitu Effects of Treated Wood, 3) Disposal of Treated Wood, and 4) Value Assessment of Treated Wood. This information will represent a strong base for use by Agriculture Canada and Environment Canada when they begin to review heavy duty wood preservatives.

Comments: The information contained in this report was not derived by MTO or specifically for MTO. This publication represents work from both MTO and a task force on preservative treated wood.

Key Words: preservative, wood, health, safety, environment, disposal

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The title page identifies only six authors for this report: E. Doyle, W. Mortimer, P. Cooper and H. Walthert who are the leaders of the respective groups identified in the Abstract; R. Taylor, the chairman of the task force who authored the introduction and, along with J. Wear, provided some organization and editing for the final report. However, it should be noted that this report represents the diligent work of many task force members, listed in Appendix IV, and not just those identified on the cover. All work was provided, on a voluntary basis, by all the participating agencies and individuals, and each should be acknowledged. Some individuals, particularly the group leaders who spent the majority of time on this work, should be particularly commended, since, in most cases, this work had to be completed in deference to their regular responsibilities.

1/ Introduction

Wood preservation is of utmost importance to a diverse group of stakeholders to assure long-term performance of treated wood structures, while alleviating risks and concerns associated with this achievement.

This report represents an interim goal of a long term objective which formally began in 1988, when the Ministry of Transportation of Ontario (MTO) formed a task force to evaluate both quality and environmental issues surrounding the use of preservative treated wood. As part of the work, MTO hosted two forums on preservative treated wood in Toronto: the first in January, 1988, and the second in September, 1990. In both cases, the participants included users (some regulatory), manufacturers of treated wood, as well as some academia; their response was very encouraging. Initially the discussions at these forums were directed towards quality. However, at the 1990 forum the environmental issues, including worker safety, became more prominent. Increased public awareness, coupled with moves by most regulatory bodies to tighten restrictions on the use of toxic substances, such as preservatives, emphasized the need to evaluate preservative treated wood as it might affect people and the environment.

Following the 1990 forum, and the suggestion of several federal agencies, MTO proceeded to transform the original task force from a provincial (Ontario) level, to a more national level. The objective of the new "Task Force on Wood Preservation" was directed at evaluating environmental issues to health and safety issues, all of which surrounded the use of heavy duty wood preservatives. As a result, the new group represented industry (chemical manufacturers and treaters), users (utilities and transportation), regulatory agencies (Health and Welfare Canada, Agriculture Canada and Environment Canada), related provincial agencies, and academia.

An inaugural meeting was hosted by MTO, in Toronto, on February 19 and 20, 1991 which was well attended by all participating agencies. The product of this meeting was twofold: it basically acknowledged that the federal government would soon announce the critical review of all heavy duty wood preservatives and, with this in mind, the task force derived an objective to assist the review. The objective was given in two parts. The overall objective of the group was "to assist in the evaluation of the use of heavy duty wood preservatives and their effects on health, safety and the environment;" the interim, or short term objective, was "to collect and summarize the available literature and identify current activities relating to health, safety and the environment with respect to the use of heavy duty wood preservatives."

This report addresses the latest findings within the interim objective of collecting and summarizing available literature and identifying current activities relating to health, safety and the environment under the following headings:

Health and Safety

Environmental In-situ Effects

Disposal

Value

Sub (working) groups were formed by the task force to investigate each of the above areas. The groups have identified data gaps, as well as recommendations for action. The recommendations are consolidated at the end of the report.

No endorsement is intended or implied pertaining to reference material cited in the report. Assessment has not been undertaken to determine the quality of findings taken from various references also cited in the report.

Agencies, TF sub-groups, participants, summaries of toxicity, and legislation are appended to the report.

2/ Health and Safety Aspects of Preservative Treated Wood

2.1/ Introduction

The Health and Safety Working Group of the Task Force on Preservative Treated Wood was assigned the responsibility of gathering information and reviewing the literature on health and safety issues related to the manufacture and use of preservative treated wood and to compile the findings and pertinent literature references into a report. This report would serve as a reference document and would also provide the information necessary to allow such products to be handled and used in a safe manner.

Health and safety issues related to the manufacture and use of a chemical substance deal with the risk or potential risk to human health and safety that workers or consumers who come into contact with the substance are exposed to, and also address the means by which such risks can be minimized. These issues encompass such areas as toxicological properties, fire and flammability hazards, first aid measures to be followed in the event of exposure, recommendations for personal protective equipment to be worn when handling the product, etc. The toxicological properties of the product are probably the most important issue to be addressed and most of the information presented in this report deals with reviewing these properties.

Although the literature on toxicological studies of the major wood preservatives (coal tar creosote, pentachlorophenol, CCA, ACA and copper naphthenate) is extensive, a complete search and listing of all these references was felt to be beyond the group's mandate. The preservative manufacturers will be expected to perform this task when Agriculture Canada announces a review of the registrations on the heavy duty wood preservatives in 1992. Instead, efforts were focused on gathering data specifically for preservative treated wood products. It is important to note that while the toxicological properties of the preservative treated wood may in fact be similar to those of the preservative used, the dosages encountered from handling the treated wood would normally be far less. Also, chemical changes do occur in some of the preservatives following treatment, and different chemical species having different toxicological properties are formed. For these reasons, caution must be exercised in drawing conclusions on the toxicity of treated wood based on the results of studies conducted on the preservative chemicals.

While not intended to meet the requirements of a complete data package, the health and safety information presented in this report should provide the reader with enough information to handle and use each of the treated wood products safely and to provide references to at least some of the toxicological studies that have been carried out to date for these products. The report is divided into two sections. In the first section, basic health and safety data for wood treated with each of the major

preservatives is presented. In the second section, relevant health and safety studies that have been carried out to assess the exposure levels and health risks involved with manufacturing, handling or using each type of treated wood product are listed. Where possible, based on the information reviewed and referenced, data gaps are identified.

2.2/ Health and Safety Data for Preservative Treated Wood

Basic health and safety data related to the handling and use of each type of preservative treated wood product follows. The data is presented in a format similar to that used by Material Safety Data Sheets (MSDS), a convenient and almost universal system used in today's workplace to alert workers to health and safety concerns involved in the use of any chemical substance. Thus, MSDS-type headings of Physical Characteristics and Composition, Fire and Flammability Hazard Data, Toxicological Properties, Personal Protective Equipment, Safe Handling Instructions, First Aid Measures and Recommendations for Use were used to summarize information for each type of treated wood product. Full MSDS's are currently being prepared by the wood treating industry for their products and these documents provided much of the basic health and safety data presented in this report. Since a person using a treated wood product should also be aware of additional hazards associated with the preservative itself, standard MSDS's have been included for each of the preservatives (see Appendix III).

2.2.1/ Ammoniacal Copper Arsenate (ACA) Treated Wood

Physical Characteristics and Composition

Wood treated with ACA is olive to bluish-green in colour and weathers to a driftwood grey over time. Seasoning after treatment renders the wood dry, paintable and odourless. The density and physical properties are essentially the same as untreated wood - e.g. a density of 450 kg/m3 in the case of red pine. The amount of preservative in the wood will range from 0.9% to 1.4% by weight, depending on the intended end use, with the preservative being composed of equal amounts of copper and arsenic compounds. In the case of wood for marine applications, the amount of preservative will be about 8% by weight.

Fire and Flammability

A. Conditions of Flammability: Combustible, keep away from open flames.

B. Extinguishing Media: Water, carbon dioxide, foam, dry chemical.

C. Hazardous Combustion Products: Normal products of combustion of wood. Arsenical fumes. Arsenic and copper in ash.

D. Special Firefighting Procedures: Self-contained respiratory equipment and full protective clothing.

E. Auto-Ignition Temperature : >265 C°

Toxicological Properties

A. Routes of Entry :

Eye contact, Skin contact, Inhalation of sawdust.

B. Effects of Acute Exposure :

Acute poisoning is very unlikely to occur except from negligent machining operations.

Eyes: Treated or untreated wood dust may cause eye irritation.

Skin: Wood dust may cause skin irritation.

Inhalation: Finely divided wood dust may cause nose, throat or lung irritation and breathing difficulty.

C. Effects of Chronic Exposure:

Adverse effects from chronic exposure to ACA treated wood have not been observed.

D. Recommended Exposure Limits :

COMPONENT	TWA (ACGIH) mg/m^3*	LD50 (ORAL) mg/kg*
WOOD, NATURAL FIBRE	1 - 5	> 2000
COPPER OXIDE	1.0	400
ARSENIC PENTOXIDE	0.2	8 (RAT) 55 (MOUSE)

* Note: Units of concentration identified in this report (typical) are: in air - mg/m^3 or kg/m^3, in water - ppm or as body weight - mg/kg or gm/kg

E. Additional Information:

Although low levels of copper and arsenic occur naturally in food, they can be hazardous at higher concentrations. The toxicity data shown above for arsenic indicate, based on the rat, that the lethal dose of wood treated for above ground exposure (4.0 kg/m3 retention) would correspond to about 120 g. In reality, larger amounts would probably be required because not all the chemicals in the wood would be liberated by digestion, and only the outer shell of individual pieces of wood are actually treated.

Direct exposure to concentrated treating chemicals only occurs in treating plants, where workers are required to take suitable precautions for their protection. In the U.S., EPA has reviewed data on the carcinogenicity, mutagenicity and reproductive or fetotoxic effects of arsenical compounds. This review process led to recommendation of the same precautions as those detailed in this document for the safe handling and use of treated wood.

Although there are toxicity data available on the individual chemical components of ACA, there are no data available on the treated wood itself. However, there is no evidence of any adverse chronic effects on workers in ACA treating plants or on those handling ACA-treated products.

Personal Protective Equipment

Hand Protection:	Wear leather gloves to prevent splinters. Wear rubber-coated gloves when handling wet wood.
Eye Protection:	Wear goggles when machining wood.
Respiratory Protection:	Wear dust mask when machining wood.
Body Protection:	Wear work clothes to avoid dermal contact when handling or machining freshly treated wood
Ventilation Controls:	Machine wood in well ventilated area or outdoors to prevent accumulation of wood dust.

Safe Handling Instructions

Handling:	Use good personal hygiene when handling freshly treated wood that has not been weathered. Wash before eating or smoking. Avoid handling and machining wet, freshly-treated wood. If sawdust accumulates on clothing,

launder before re-use. Wash work clothes separately from other household clothing.

Good Housekeeping: Maintain a clean workplace. Clean up scrap lumber and sawdust. Wear dust mask when cleaning up sawdust.

Disposal: It is not recommended to burn treated wood in stoves, fireplaces or open fires near dwellings. Incineration of ACA treated wood may be possible in approved facilities. Contact the local provincial or federal authorities for additional information. Small quantities of treated wood may be disposed of by ordinary trash collection or by burial.

First Aid Measures

Eye Contact: Rinse eyes to remove any small particles of wood, then flush with water.

Inhalation: If breathing difficulty is experienced through prolonged machining activities without a dust mask, move to fresh air and contact physician.

Ingestion: If wood is ingested, contact physician.

Uses of ACA Treated Wood

Do not use ACA treated wood in applications where the preservative may become a component of food or animal feed such as in construction of containers for silage or food, or in construction of beehives.

Do not use ACA treated wood for cutting boards or counter tops.

Wood to be used for patios, decks and walkways should be free from surface deposits of preservative.

ACA treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

ACA treated wood is primarily intended for use as construction lumber and timber, utility and construction poles, marine timbers and piling, fence posts, and foundation piling.

Before using an ACA treated wood product, the worker or consumer should refer to the Material Safety Data Sheet for ACA treated wood. He or she may also refer to the Material Safety Data Sheet for the preservative itself for additional information.

2.2.2/ Chromated Copper Arsenate, Type C (CCA-C) Treated Wood

Physical Characteristics and Composition

Wood treated with CCA-C preservative is light to dark green in colour and has no odour. The density and physical properties are essentially the same as untreated wood - e.g. a density of 450 kg/m3 in the case of red pine.

In wood treated with CCA-C, the retention of the preservative typically ranges from 4.0 to 40 kg/m3 (0.25 to 2.5 pcf), depending on the intended use of the product. Over this range of retentions, the concentration of arsenic pentoxide will range from 0.3 to 2.6%, copper oxide from 0.15 to 1.3%, trivalent chromium from 0.4 to 3.3% and wood (natural fibre) from 92.8 to 99.2%.

Fire and Flammability Hazard Data

A. Conditions of Flammability:	Combustible, keep away from open flames.
B. Extinguishing Media:	Water, carbon dioxide foam, dry chemical.
C. Hazardous Combustion Products:	Normal products of combustion of wood. Arsenic containing fumes. Arsenic, copper and chromium residues in ash.
D. Special Firefighting Procedures:	Self-contained respiratory equipment and full protective clothing.

Toxicological Properties

A. Routes of Entry:

Skin contact

Inhalation

B. Effects of Acute Exposure:

Wood dust may cause skin irritation and breathing difficulty, but because CCA-C treated wood has a low order of toxicity, acute poisoning is very unlikely to occur.

C. Effects of Chronic Exposure:

Adverse effects from chronic exposure to CCA-C treated wood have not been observed.

D. Recommended Exposure Limits:

COMPONENT	TWA (ACGIH) mg/m^3	TLV (ACGIH) mg/m^3	LC50 ppm	LD50 (ORAL) mg/kg
WOOD, NATURAL FIBRE	1 - 5	1.0	--	> 2000
TRIVALENT CHROMIUM	--	0.5	--	--
COPPER OXIDE	1.0	0.1	--	400
ARSENIC PENTOXIDE	0.2	0.2	--	50

-- Data not available

E. Additional Information:

Irritancy: Wood dust is irritating to mucous membranes and eyes

Sensitization: No derma irritation

Carcinogenicity: Arsenic is listed as a carcinogen or potential carcinogen. However, epidemiological studies of carpenters and cross-sectional medical studies of treating plant workers have not shown an increased risk of cancer.

Reproductive Toxicity: No effect

Teratogenicity: No teratogenic effects

Mutagenicity: No mutagenic effects

Toxicologically Synergistic Products: None

Personal Protective Equipment

Hand Protection: Wear rubber gloves when handling wet wood

Wear leather gloves to avoid splinters

Eye Protection:	Wear goggles when machining wood
Respiratory Protection:	Wear dust mask when machining wood. When machining wet wood, a respirator may be required
Body Protection:	Wear work clothes to avoid dermal contact when handling or machining freshly treated wood.
Ventilation Controls:	Machine wood in well ventilated area or outdoors to prevent accumulation of wood dust.

Safe Handling Instructions

Handling: Follow good personal hygiene practices in the shop and on the job. After working with the wood, and before eating, drinking and use of tobacco products, wash exposed areas thoroughly. Avoid handling or machining wet, freshly treated wood unless specified safety precautions are observed.

Disposal: It is not recommended to burn treated wood in stoves, fireplaces or open fires near dwellings. Incineration of CCA-C treated wood may be possible in approved facilities. Contact the local provincial or federal authorities for additional information. Small quantities of treated wood may be disposed of by ordinary trash collection or by burial.

First Aid Measures

Eye contact:	Rinse eyes to remove any small wood particles then flush with water for at least 15 minutes.
Inhalation of dust:	Move victim to fresh air.
Ingestion:	Unlikely but if it occurs, contact physician.

Uses of CCA-C Treated Wood

Do not use CCA-C treated wood in applications where the preservative may become a component of food or animal feed such as in construction of containers for silage or food, or in construction of beehives.

Do not use CCA-C treated wood for cutting boards or counter tops.

CCA-C treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

CCA-C treated wood is primarily intended for use as construction lumber and timber, utility poles, marine timbers and piling, fence posts and decking.

Before using a CCA-C treated wood product, the worker or consumer should refer to the Material Safety Data Sheet for CCA-C treated wood. He or she may also refer to the Material Safety Data Sheet for the preservative itself for additional information. However, in the case of CCA-C, chemical changes do occur in the preservative following treatment so that the toxicological properties of the preservative in the treated wood are different from those of the preservative itself.

2.2.3/ Copper Naphthenate Treated Wood

Physical Characteristics and Composition

Wood treated with copper naphthenate may range from light green to dark brown in colour, depending on the treating process, the solvent, and the treating temperature. Copper naphthenate is a solvent soluble wood preservative. The solvent used will depend on the commodity which is being treated. The most commonly used carrier solvents are fuel oil and mineral spirits. Wood treated with copper naphthenate in oil has a characteristic petroleum aromatic odour. Wood treated with copper naphthenate in mineral spirits has a characteristic aliphatic hydrocarbon odour.

In copper naphthenate treated wood, the retention of the preservative typically ranges from 0.64 to 2.4 kg/m3 (0.04 to 0.15 pcf) as copper, depending on the intended use of the treated product. Over this range of retentions, the concentration of copper in the wood will range from approximately 0.13 to 0.78%. The specific gravity of copper naphthenate treated wood is typically 0.60 to 0.70.

Fire and Flammability Hazard Data

A. Conditions of Flammability:	Combustible, keep away from open flames.
B. Extinguishing Media:	Water, carbon dioxide, foam, dry chemical.
C. Hazardous Combustion Products:	Petroleum Distillates, wood combustion products (Carbon monoxide, carbon dioxide).

D. Special Firefighting Procedures: Self-contained apparatus with a full face piece operated in pressure demand or other positive pressure mode to protect against inhalation of combustion products and wood smoke.

Toxicological Properties

A. Routes of Entry:

Eye contact, Skin contact, Inhalation, Ingestion.

B. Effects of Acute Exposure:

Eyes: Can cause severe irritation, redness, tearing, and blurred vision.

Skin: Prolonged or repeated contact can cause moderate irritation or dermatitis.

Inhalation: Finely divided wood dust, treated or untreated, may cause nose, throat, or lung irritation and other respiratory effects. Preservative vapour may cause respiratory tract irritation. If exposed in a closed space, vapours may produce headache, drowsiness, and possible weakness and uncoordination.

Ingestion: Eating treated sawdust may cause mouth, throat, and stomach irritation. Nausea, vomiting, and diarrhoea can occur.

C. Effects of Chronic Exposure: Neither copper naphthenate nor wood dust are listed on the IARC, NTP, or OSHA carcinogen lists.

D. Recommended Exposure Limits:

Component	%	TLV	LD50 (1)
Copper Naphthenate	2	1 mg/m3 as Copper (2)	Oral: > 5 gm/kg
			Dermal: > 2 gm./kg
Petroleum Solvent	14		Oral: 9 gm/kg(3)
Natural Wood Fibre	84	Hardwood: 1 mg/m3 (4)	
		Softwood: 5 mg/m3 (5)	

(1) Obtained by Applied Sciences Laboratory of Glendale, California using a mineral spirits solution of Copper Naphthenate containing 2% copper, the typical concentration of an over-the-counter, brush-on wood preservative. These LD50 values are for the treatment chemical, not the treated wood. No exposure limit is established for the treated wood.

(2) OSHA, 29 CFR 1910.1000, Table Z-1 lists "Copper, dusts, and mists".

(3) Registry of Toxic Effects of Chemical Substances, 31428, 1985-86

(4) as dust, ACGIH-TLV/TWA, 1987-88

(5) as dust, ACGIH-TLV/TWA; STEL 10 mg/m3 , 1987-88

Personal Protective Equipment

Eye Protection: Industrial safety glasses, minimum. As necessary to comply with 29 CFR 1910.133 and work area conditions: use side shields, goggles, or face shield. When power sawing and machining, wear goggles to protect eyes from flying particles.

Skin Protection: When handling the wet chemically-treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example,

gloves that are vinyl-coated). After the wood is dry, wear any type of glove to protect from splinters.

Respiratory Protection: When sawing or machining treated wood, wear a dust mask.

Safe Handling Instructions

Handling: Avoid frequent or prolonged inhalation of sawdust from treated wood. Avoid frequent or prolonged skin contact with treated wood. After working with the wood and before eating, drinking or use of tobacco products, wash exposed areas thoroughly. If oily preservatives or sawdust accumulates on clothes, launder before re-use. Wash work clothes separately from other household clothing.

Disposal: Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or stoves, fireplaces, or residential boilers. Treated wood from commercial or industrial use (e.g. construction sites) may be landfilled or burned in commercial or industrial incinerators or boilers in accordance with Provincial and Federal regulations.

First Aid Measures

Eye Contact: Flush with large amounts of water, lifting upper and lower lids occasionally. Get medical attention.

Skin Contact: Thoroughly wash exposed area with soap and water. Remove contaminated clothing. Launder before re-use.

Inhalation: Remove individual to fresh air. If breathing is difficult, administer oxygen. If breathing is stopped, give artificial respiration. Keep person warm, quiet. Get medical attention.

Ingestion: Do not induce vomiting. Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal.

Storage: No special storage is required.

Uses of Treated Wood/Other Comments

Use Site Precautions:

Wood treated with copper naphthenate should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), or for interior use unless an effective sealer has been applied. Urethane, shellac, latex paint, epoxy enamel and varnish are acceptable sealers for Copper Naphthenate treated wood. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Example of such sites would be structures or containers for storing silage or food. Do not use treated wood for cutting boards or counter tops. Only treated wood that is visibly clean and free of surface residue should be used for patios, decks, and walkways. Copper naphthenate treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for use involving incidental contact such as docks and bridges.

Before using a copper naphthenate treated wood product, the worker or consumer should refer to the Material Safety Data Sheet for copper naphthenate treated wood. He or she may also refer to the Material Safety Data Sheet for the preservative itself for additional information.

2.2.4/ Creosote Treated Wood

Physical Characteristics and Composition

Wood treated with coal tar creosote is dark brown to black in colour and has a characteristic petroleum aromatic odour. The specific gravity for creosote treated wood is typically 0.66 for hardwoods and 0.59 for softwoods.

Hazardous Ingredients:

	Marine Applications	Other Applications
Wood (Natural Fibre)	65 - 45 % w/w	70 - 60
Water	10% w/w	20
Creosote (CAS 8001 - 58 - 9)	25 - 45 % w/w	10 - 20

Fire Flammability Hazard Data

A. Conditions of Flammability: Creosote Treated wood is a combustible material and as such it should be kept away from open flames.

B. Extinguishing Media: Should this product ignite and burn, it may be extinguished using water, CO_2, foam or dry chemical.

C. Hazardous Combustion Products: Same as untreated wood, namely CO_2,SO_2,NO_x,CO, PAH's.

D. Special Fire Fighting Procedures: Self-contained respiratory equipment and full protective clothing.

Toxicological Properties

A. Routes of Entry:

Treated wood is unlikely to enter the body of an exposed worker under common use practices. However, particles of wood (sawdust) may be inhaled during cutting operations and splinters may injure unprotected skin while handling the treated wood. Eye contact with vapours and fumes may also occur during cutting and machining operations.

B. Effects of Acute Exposure:

Due to the high infinity of the chemical for the wood, it is unlikely that acute or chronic health ailments will result from incidental exposure to the treated wood. However, for workers handling or cutting the freshly treated wood on a regular basis, both acute and chronic health effects may be a concern.

No toxicology data are available specifically for wood treated with Creosote. Acute toxicity of the chemical (about 725 mg/kg) would indicate a lethal dose of treated wood of approximately 200 g (marine application) to 400 g (other applications). This assumes that 50% of the chemical would be released in the body.

C. Effects of Chronic Exposure:

Recent studies of chronic exposure of workers in wood treatment plants showed no chronic effects from exposure to the chemical or the treated wood. The studies in North America and Europe indicated the same risk of cancer for the worker exposed as for the general population of similar age groups.

D. Recommended Exposure Limits:

Component	TWA (ACGIH) mg/m^3	LC50 mg/kg
Wood, natural fibre	1-5	N/A
Coal tar Creosote	0.2	725

E. Additional Information:

Skin contact with the chemical may produce irritation, pigmentation of the skin, photo-toxicity (in the presence of sunlight). These effects may be avoided with good personal hygiene practices including washing with soap and water, avoiding eating where dust is present and washing of clothes before reuse.

Personal Protective Equipment

Personal protection equipment shall be used as required on the labels when handling the pure chemical or the freshly treated wood.

Based on the requirements developed for the pure chemical, the following is recommended for the treated wood.

Hand Protection:	Gloves (impervious -PVA, Neoprene, PVC), use of barrier creams
Eye Protection:	Safety Glasses. If there is likely exposure to Creosote vapour/fumes, then goggles are recommended.
Respiratory Protection:	Dust mask (during cutting) or NIOSH approved mask for organic vapours if exposed to Creosote vapour/fumes.
Body Protection:	Full clothing, use of barrier creams as appropriate.
Foot Protection:	Safety Boots
Ventilation:	Treated wood should not be stored indoors.

Safe Handling Instructions

Handling: Avoid frequent or prolonged inhalation of sawdust from treated wood. Avoid frequent or prolonged skin contact with treated wood. After working with treated wood and before eating, drinking or using tobacco products, wash exposed areas thoroughly. If oily preservative or sawdust accumulates on clothes, launder before re-use. Wash work

clothes separately from other household clothing. It is advisable for workers to shower before leaving work where they have been handling treated wood. Work clothes should be separate from street clothes.

Disposal: It is not recommended to burn treated wood in stoves, fireplaces or open fires near dwellings. Incineration of creosote treated wood may be possible in approved facilities. Contact the local provincial or federal authorities for additional information. Small quantities of treated wood may be disposed of by ordinary trash collection or by burial. Creosote treated wood ashes do not contain heavy metals (other than those naturally occurring in wood).

First Aid Measures

Skin Contact: Wash well with water and soap. Wash contaminated clothing before reuse.

Eye Contact: Flush eyes thoroughly with cold water for 15 minutes, keeping the eyelids open. Contact physician.

Ingestion: Unlikely, but if occurs contact physician at once.

Inhalation: Move the victim to fresh air. If breathing has stopped administer CPR. Call physician at once.

Additional Information

The use of Creosote for wood treatment is regulated under Agriculture Canada by the Pesticide Directorate. The use of Creosote treated wood is not allowed where contact with drinking water is possible. Also the use of Creosote treated wood is not allowed for residential construction.

Before using a creosote treated wood product, the worker or consumer should refer to the Material Safety Data Sheet for creosote treated wood. He or she may also refer to the Material Safety Data Sheet for the preservative itself for additional information.

2.2.5/ Pentachlorophenol Treated Wood

Physical Characteristics and Composition

Wood treated with 5% pentachlorophenol in oil is tan to dark brown in colour and has a characteristic petroleum aromatic odour.

In pentachlorophenol treated wood, the retention of the preservative typically ranges from 4.8 to 12.8 kg/m3 (0.30 to 0.80 pcf) depending on the intended use of the treated product. Over this range of retentions, the concentration of pentachlorophenol will range from approximately 0.8% to 2.2%. The specific gravity of pentachlorophenol treated wood is typically 0.66 for hardwoods and 0.59 for softwoods.

Fire and Flammability Hazard Data

A. Conditions of Flammability:	Combustible, keep away from open flames
B. Extinguishing Media:	Water, carbon dioxide, foam, dry chemical
C. Hazardous Combustion Products:	Wood combustion products, hydrochloric acid, chlorinated organics, traces of chlorinated dioxins and furans
D. Special Firefighting Procedures:	Self-contained respiratory equipment and full protective clothing

Toxicological Properties

A. Routes of Entry:

Eye contact, skin contact, skin absorption, inhalation, ingestion

B. Effects of Acute Exposure:

Eyes:	irritant
Skin:	irritant
Inhalation:	N/AV (Not Available)
Ingestion:	N/AV

C. Effects of Chronic Exposure:

N/AV

D. Recommended Exposure Limits:

COMPONENT	TWA (ACGIH) mg/m^3	TLV (ACGIH) mg/m^3	LC50 ppm	LD50 (ORAL) mg/kg
WOOD, NATURAL FIBRE	1 - 5	1	--	> 2000
POLE TREATING OIL	--	5	4000	8000
PENTACHLOROPHENOL	--	0.5	300	50

– Data not available

E. Additional Information

Based on results of tests carried out on technical grade pentachlorophenol, not wood treated with pentachlorophenol, the following information on the potential toxic effects can be made.

Irritancy: Pentachlorophenol (penta) is an eye irritant in animals and can cause focal erosion of the cornea persisting for at least 3 days following exposure. There is some evidence that penta in man causes irritation of the membranes surrounding the eye.

Sensitization: No animal dermal sensitization studies have been reported. However, human epidemiology studies have been reported without mention of sensitization reactions. Dermal and subcutaneous exposure to penta are known to induce local effects in a variety of animals including man. The effects seen include skin damage, swelling and hair loss. Long-term studies in rabbits suggest that dermal lesions associated with exposure are induced by the micro-contaminants of penta rather than penta itself. In man, technical grade penta can induce chloracne.

Carcinogenicity: There are a number of studies which have been performed to evaluate the oncogenicity/tumorigenicity of penta. Based on these data, the only unequivocally positive finding in rats or mice of either sex is an increased incidence of hemangiosarcomas found in female mice in one study. Other data do not support the proposition that penta is a carcinogen in animals or man.

Reproductive Toxicity: There are three reproduction studies available on penta. All support the conclusion that penta does not affect fertility of either the adult male or female rat. The effect observed in neonatal animals is phytotoxicity, not reproductive toxicology, and it is observed at doses which are toxic to the dam (>3 mg/kg/day).

Teratogenicity: Penta has been found to be embryo and phytotoxic to rats, but not to hamsters. Penta did not cause teratogenic effects (birth defects), but did cause delays in normal fetal development. Delayed developmental effects (not teratogenicity) such as ossification of the skull, variations in vertebrae and lumbar spurs have been observed at high doses of penta.

Mutagenicity: Based upon a very large number of studies in the literature, the overwhelming weight-of-evidence conclusion is that penta is not mutagenic. It is at most a weak clastogen, with weak clastogenic activity having been observed only in a small minority of the available reports.

Personal Protective Equipment

Eye Protection: None. Wear goggles when machining wood.

Hand Protection: PVC, neoprene, nitrile latex or equivalent gloves

Body Protection: Full clothing

Respiratory Protection: Only required in unlikely event of fumes exceeding TLV for pentachlorophenol.

Safe Handling Instructions

Handling: Avoid frequent and prolonged inhalation of sawdust from treated wood. Avoid frequent or prolonged skin contact with treated wood. Gloves should always be used when handling product as pentachlorophenol is easily absorbed through skin. After working with wood and before eating, drinking or use of tobacco products, wash exposed areas thoroughly. If oily preservative or sawdust has accumulated on clothes, launder before reuse. Wash work clothes separately from other household clothing.

Disposal: Use approved landfill site in conformance with local regulations. It is not recommended to burn treated wood in stoves, fire places or in open fires near habitations. Small quantities of treated wood may be disposed of by ordinary trash collection or by burial.

First Aid Measures

Eye Contact: Flush eyes thoroughly with water for 15 minutes.

Skin Contact: Wash well with soap and water. Wash contaminated clothing before reuse. Boots saturated with oil containing pentachlorophenol should be discarded.

Inhalation: Move victim to fresh air.

Ingestion: Unlikely, but if it occurs contact physician.

Uses of Treated Wood/Other Comments

Pentachlorophenol treated wood should not be stored or used indoors. Pentachlorophenol treated wood should not be used in fresh water or marine installations such as docks and wharfs.
Before using a pentachlorophenol treated wood product, the worker or consumer should refer to the Material Safety Data Sheet for pentachlorophenol treated wood. He or she may also refer to the Material Safety Data Sheet for the preservative itself for additional information.

2.3/ Health and Safety Studies on Preservative Treated Wood

In this section, selected health and safety studies relating specifically to the handling and use of preservative treated wood, either during manufacture or by workers or consumers who use or are exposed to the treated wood products after they have left the plant, are reviewed. These studies typically relate to measuring preservative exposure levels for workers and others who are in contact with treated wood products. Such studies are important in determining the uptake of preservative chemicals by the body through frequent or casual contact with treated wood and for estimating possible health risks associated with such uptake. For those studies that have been carried out in treating plants, it is important to note that in these cases, workers may be exposed directly to the preservative chemical during the treatment process as well as to the treated wood. Also, while some of these latter studies are dated, and may not accurately reflect the current practices found in Canadian treating plants, the results provide an estimate of the types of exposure levels that might be encountered by plant workers. Finally, laboratory studies involving the exposure of test animals to preservative treated wood were also reviewed. These studies are important since the results are used by toxicologists to predict human health risks.

No attempt has been made to review and list all the available studies dealing with the toxicology of the wood preservatives themselves. A large body of literature exists on this subject, and was assessed by EPA in their extensive review conducted between 1978 and 1984 (U.S. EPA, 1978, 1981, 1984). New studies have also been initiated by the chemical suppliers to generate additional data. This information will be made available to Agriculture Canada for their planned re-evaluation of the wood preservatives in 1992.

The information presented here is intended for reference purposes only and the reader is cautioned against attempting to make health risk assessments involved in the handling or use of preservative treated wood products based solely on the results found in any of these studies.

CCA-C and ACA Treated Wood

A number of laboratory toxicity studies have been carried out dealing specifically with the exposure of test animals to CCA-C treated wood. Thus, the acute oral toxicity of the treated wood was evaluated in a study carried out by Boliden, the Swedish producer of arsenic trioxide, and reported by Wilson (1991). No lethal effects were observed in rats which were fed up to 7000 mg/kg/day for 10 days with wood containing 9.6 kg/m3 of CCA-C. In another study carried out by Peoples (1979), CCA-C preservative was found to be rapidly excreted in the urine and faeces of dogs that had ingested up to 1 in 3 of wood treated to 6.4 kg/m3 of preservative per day for 4-5 days. There were no observable toxic effects.

Dermal absorption of CCA-C and ACA preservatives from treated wood has also been studied. Peoples (1979) applied patches of treated wood sawdust to the shaved skin of dogs. No uptake of preservative through the skin and no skin irritation was observed. Naas (1988) studied the acute toxicity (primary eye irritation) of CCA-C treated wood in rabbits. Sawdust from wood treated to a 9.6 kg/m3 retention level was found to be less irritating than untreated wood sawdust. However, both were rated as moderate irritants using standard FIFRA protocol.

Special toxicity studies have also been conducted on CCA-C treated wood. Hood (1979) evaluated teratology effects in mice and rabbits via the oral and dermal routes. Thus, mice were fed up to 21600 mg treated wood/kg/day throughout pregnancy. No effects were observed on the test animals or on developing fetuses. In the same study, a paste containing treated wood sawdust (9.6 kg/m3 retention) in water was applied to 5% of the body area of pregnant rabbits over a 16 day period. There was no observed effects on the test animals or developing fetuses, nor was any skin irritation found. Finally, in a study carried out by Graham (1979), cytological effects of the treated wood were evaluated using mice. No mutagenic effects were found in the test animals that had been fed a diet containing 10% sawdust from CCA-C treated wood (9.6 kg/m3 retention).

In addition to these laboratory toxicity studies, various researchers have examined the potential health risks involved in handling CCA-C treated wood during occupational as well as casual exposure. A number of these studies relate to measuring the levels of toxic elements present on the surface of CCA-C treated wood which may be dislodged during contact. Johannson (1973) examined roundwood pine stock treated commercially with CCA preservative for amounts of arsenic and copper remaining on the

surface of unweathered material. Up to 4 mg of arsenic was found on the round surfaces and 6-16 mg on the ends, expressed as arsenic/100 cm^2. A similar amount of copper was also found. Although the health hazard appeared to be very small, the authors recommended caution since a considerable variation is possible in the extent of fixation of the CCA components and because there is uncertainty as to the toxicity of the fixed arsenic to humans. They also recommended that the treated wood be thoroughly washed before being made accessible to children.

A recent study carried out by the U.S. Consumers Products Safety Commission, and reported by AWPI (1990), attempted to estimate the potential risk of skin cancer from dislodgeable arsenic on the surface of treated wood. Samples of CCA treated wood were obtained from major U.S. manufacturers of playground equipment and the amounts of dislodgeable arsenic residues on the surfaces were measured. The estimated risk of skin cancer for five out of seven samples in which dislodgeable arsenic residues were below the detection limit for arsenic was less than 1 chance in a million (negligible risk). For two other samples, which showed detectable levels of arsenic in the wipe samples, an estimated risk of 3-4 in a million was calculated. A final sample purchased at a retail store had the highest estimated risk (8-9 in a million). This final result suggested a possible hazard might be created when playground equipment is built with unfinished pressure treated wood obtained from retail sources.

In the most recent study, Galarneau (1990) examined residues of arsenic, copper and chromium associated with CCA-C treated lumber in playground structures. In this study, wood surface wipe and sand and soil samples were collected from or around a number of outdoor play structures which had been constructed of CCA treated lumber. The levels of these three elements in the wipe samples indicated that the treated wood had dislodgeable surface residues which could lead to some user exposure and to leaching of the preservative components from the wood. The authors of the study recommended that it might be advisable to seal the surface of the wood with a protective coating in order to protect the environment as well as the users of such structures. A continuation of this study is currently underway to develop more quantitative data.

Cooper (1990) carried out an extensive review of the literature on the leaching and dislodgeability of CCA from treated wood. Although a number of studies on dislodgeability were reviewed, the author found that because of different procedures used to collect samples, valid comparisons between the results from the various studies could not be made. While individual authors interpreted their results differently, the general conclusion from most of the studies indicated health risks from dislodgeable CCA components to be minimal or neglible.

Several studies have also been conducted to determine levels of respirable arsenic emissions from CCA-C and ACA treated wood. Saur (1983) developed sampling and analytical techniques to measure respirable levels of arsenic on samples of CCA-C treated wood in service. The amount of respirable arsenic found on the surface was low for most wood surfaces examined and ranged from 0.01-12.7 mg respirable arsenic/m2. In another study, Williams (1983) attempted to develop information on arsenic emissions resulting from the indoor use of CCA-C and ACA treated wood. Air exhausted from test structures built of treated plywood was sampled for airborne arsenic over various periods of time. Mean arsenic levels of -1.75 to +1.39 nanogram/m3 were found and the study concluded that the arsenic contribution of treated wood at typical use levels would be below detection limits.

Possible health effects to workers involved in kiln drying of treated wood has also been investigated. Williams (1984) attempted to characterize the airborne emissions and waterborne drainings from kilns during the drying of CCA-C treated wood. Thus, the airborne emissions vented from a kiln and water drained from the wood during drying were analyzed for copper, chromium and arsenic. The results showed that these metals are not vaporized or physically entrained at significant levels in the circulating kiln environment. Low levels (15-30 mg/l) of the metals in the liquid drainings also suggested that the treatment was highly "fixed" in the wood. In another study, Edlund (1985) investigated the effects that various drying procedures and schedules might have on subsequent health hazards associated with handling the kiln-dried CCA-C treated lumber. No significant differences in the amounts of preservative chemicals on the surface of the wood resulted from the various drying procedures evaluated.

The release of toxic elements resulting from the burning of CCA treated wood and possible health hazards has also been studied. McMahon (1986) found that small amounts of copper and chromium and amounts of arsenic varying from 22-77%, depending on combustion conditions, were released when CCA treated wood was burned under laboratory conditions. Dobbs (1976) had reported similar values in his work, with evolution rates for arsenic, presumably arsenic trioxide, ranging from 20-90% from burning CCA treated wood. He also cautioned that since the combustion process converts significant amounts of arsenic and chromium into water soluble forms, the ash itself can be potentially toxic. It is important to note that the burning of treated wood is not recommended by the industry.

Possible health hazards and environmental problems associated with treatment of wood with CCA preservatives was also investigated by Bringezu (1987). This study showed that occupational exposure to arsenic is possible by workers in treating plants as well as by those working with treated wood. Although wood treated with CCA is thought to be relatively safe during its use, considerable amounts

of arsenic can be loaded into the environment under severe leaching conditions, and large amounts (20-80%) can be released if the treated wood is burned. The released arsenic is in a form for which carcinogenic potential has been shown.

Finally, the analysis of human hair and nail samples has been used as a means of monitoring worker exposure to CCA preservative. In a study reported by Ndiokwere (1985), the arsenic levels in hair and nail samples from workers in a treating plant in Nigeria were measured and compared to a control group. The mean arsenic concentrations in hair samples were found to range from 1.6 - 11.6 ppm and from 1.0 - 7.4 ppm in nail samples and were significantly higher than those reported for the control group (1.2 and 0.64 ppm respectively). The author also reported a good correlation between the arsenic levels found and the duration of employment for workers with similar exposure ratings. While the results would not be expected to be applicable to Canadian treating plant workers because of differences in plant equipment, operating procedures and safety standards, the study does show that hair and nail analysis could be a useful exposure monitoring tool.

Coal Tar Creosote Treated Wood

The exposure of workers to coal tar creosote during the treatment of wood and in the subsequent handling of the treated wood was studied by Heikkila (1987). In the study, the major components of vapours and polycyclic aromatic hydrocarbons in particulate matter were identified and quantified in two creosote treating plants and in the handling of treated wood during specific operations. These operations included the repair of old rails, the replacement of rails in a railroad yard, the welding of switches, the manufacture of switch elements in a plant and the loading of poles on ships. Mean vapour concentrations were found to range from a low of 0.1 mg/m3 for railroad workers repairing track to a high of 11 mg/m3 for workers assembling switch elements indoors.

Henningsson (1983) reviewed the literature on environmental and health risks associated with the use of creosote in wood preservation. The examination considered toxic and hazardous problems caused by the use of creosote in treating plant operations, and environmental problems posed by treated wood in service. The study concluded that any possible problems are not severe and can be reduced or eliminated by the use of fairly simple protective measures.

Copper Naphthenate Treated Wood

No studies relating specifically to copper naphthenate treated wood were found.

Pentachlorophenol Treated Wood

The occupational exposure of electrical utility linemen to pentachlorophenol was studied by Thind (1991). In the study, volunteer linemen from four locations in Ontario were monitored using a biological technique (PCP in urine). The study found that although linemen exposures were elevated relative to controls, exposures were well below the established guidelines of 125 and 1000 microgram/gram creatine. The exposure levels showed a seasonal pattern, peaking in the summer. Also, there appeared a significant correlation between urinary PCP and PCP levels found in workers' gloves.

The exposure and contamination of the air and employees of a pentachlorophenol plant in Idaho was studied by Wyllie (1975). The workers were monitored over a 5 month period for PCP exposure. Both serum and urine samples were taken. Serum PCP levels ranged from 348.4 to 3963 ppb for the exposed group and from 38.0 to 68.0 ppb for the control group, while urine levels ranged from 41.3 to 760.6 ppb for the workers and 2.6 to 4.3 ppb for the control. There was no statistical difference in the number of chromosomal aberrations between the exposed workers and the control group. Concentrations of PCP in serum and urine of persons that have used wood preserving chemicals containing pentachlorophenol were measured against a control group in a similar study by Butte (1985). Average values of 30 microgram/l of PCP in urine and 38 microgram/l PCP in serum were slightly above similar values for the control group.

In another study, Jones (1986) monitored plasma and urinary PCP levels in 209 workers who had occupational exposure to wood preservatives containing pentachlorophenol and compared them to a control group. All the exposed workers showed evidence of PCP adsorption, with the highest mean concentration found in those involved in remedial treatments (6.0 mmol/l plasma, 274 nmol/mmol creatine for urine). Timber yard workers also showed substantial PCP adsorption (mean plasma concentration, 4.8 mmol/l), while workers involved in formulating PCP preservatives had the lowest concentrations of any exposed group. There was no evidence of any ill effects of PCP exposure on health as measured by the parameters used.

Combined Studies

Several health and safety related studies have also been conducted in which the authors have evaluated exposures to more than one type of preservative. In a study by Antonsson (1985), exposure to airborne preservative chemicals at CCA and creosote treating plants was evaluated. The observed concentrations of copper, chromium and arsenic were generally very low and there was no risk of exceeding TLV's, except when the treating cylinder door was opened at the end of the treating cycle. At

this time, high concentrations of chromium were observed. Similarly for creosote, the highest concentrations of naphthalene and biphenyl occurred when the cylinder was opened. The author makes suggestions for improving plant procedures to avoid these momentary high levels of preservative vapours.

In a very comprehensive study by Todd (1983), industrial hygiene surveys of occupational exposure to wood preservative chemicals were carried out. These studies were conducted at eleven wood treating plants and two manufacturing operations in order to evaluate worker exposure to wood preserving chemicals. Employee exposures to preservative chemicals during the treatment process were found to be well below current applicable occupational standards, although short-term peak exposures occur during some operations (ie,opening cylinder door, inspecting and sampling freshly treated wood). The exposure levels measured were all well below current guidelines for significant health risk.

The environmental and health and safety aspects of wood preservation were reviewed by Greaves (1987). In this paper, the author examined the health and safety concerns related to the use of CCA's, creosote, pentachlorophenol, copper naphthenate and other preservative chemicals, and attempted to place in proper perspective the value of wood preservation. Although the review concentrates mainly on exposure to the preservative chemicals during treating plant operations, precautions are given for handling both the preservatives as well as the treated wood. Based on his review, the author suggests that preservative treated wood, as opposed to the unreacted treatment chemicals, does not represent a hazard to health or the environment.

The morbidity and mortality of workers occupationally exposed to wood treating chemicals (CCA, TBTO, PCP) used in Hawaii for the years 1960-1981 were evaluated in a study by Gilbert (1990). Although there were higher urinary PCP levels in the occupationally exposed cases as compared to controls (mean of 174 ppb vs. 35 ppb), the results indicated no adverse health effects or increased incidence of mortality resulting from exposure to wood preservatives in people who had worked in the industry for 0.33 to 26.3 years (median of 6.5 years).

Finally, in a series of reports to Environment Canada, Konasewich (1988) reviewed current state of the art practice for the design and operation of wood treating facilities in Canada (CCA, ACA, creosote and pentachlorophenol). Among topics discussed in these reports are human health concerns for workers in the plants and recommended safety precautions for workers involved in all aspects of plant operations, including the handling of freshly treated lumber.

2.4/ Recommendations

Based on the literature reviewed and group discussions, the following recommendations are proposed.

1. Primary Exposure Studies on Treating Plant Workers

At the initial meeting of the group, Health and Welfare Canada officials indicated that there was a definite lack of data in the area of primary exposure studies on treating plant workers. While acknowledging that the literature does contain some references in this area, they felt that most of these studies were not quantitative enough to make sound recommendations on exposure levels. It would probably be necessary to carry out studies in which plant workers are identified by the degree of daily exposure they have to the wood preservatives and then determine actual exposure levels for these workers by means of passive dosimetry, inhalation and/or biological monitoring techniques. A new document, "Canadian Guidelines for Agricultural Pesticide Exposure" will be available in 1992 and should provide additional information in this area.

2. Data Gaps for Toxicity of Preservative Treated Wood

The toxicity data presented in section 2.2 of this report for the five types of preservative treated wood contain a number of data gaps, indicated in the text as data not available. The suppliers of preservative treated wood should locate or develop the data necessary to fill these gaps.

3. Data Gaps for Toxicity of Wood Preservatives

Since the re-evaluation of heavy duty wood preservative registrations by Agriculture Canada is expected to commence shortly, any gaps in the toxicity data packages for these preservatives would be expected to be identified by the appropriate federal authorities at that time. Therefore, no further activity by the Working Group in this area is recommended.

2.5/ References

Antonsson, A., Lundberg,B. 1985. Investigations of Health Hazards in the Wood Preserving Industry, Swedish Wood Preservation Institute, Report No.152.

Bringezu, S. 1987. Arsenic in Wood Preservation. Possible Hazards to Health and Environment, Holz als Roh und Werkstoff, 47(5).

Butt, W., 1985. Pentachlorophenol Concentrations in Serum and Urine of Persons that Have Used Wood Preserving Agents, J. Clin. Chem. Clin. Biochem., 23(9), 599.

Cooper, P.A. 1990. Leaching of CCA from Treated Wood. Canadian Wood Preservation Association, Proceedings of Eleventh Annual Meeting.

Dobbs, A.J., Grant, C. 1976. Report on the Burning of Wood Treated with Wood Preservatives Containing Copper, Chromium and Arsenic, Building Research Establishment, Princess Risborough Laboratory.

Edlund, M.L., Henningsson, B., 1985. Investigations of Wood Treated with Water-borne Preservatives and Sap-stain Chemicals. Efficacy and Health Hazards after Various Methods of Drying, Swedish Wood Preservation Institute, Report No.153.

Galarneau, D., Riedel, D., Harrison, J., Gregoire, D.C., Bertrand, N. 1990. Residues of Arsenic, Chromium and Copper on and near Outdoor Structures Built of Wood Treated with "CCA" Type Preservatives, American Chemical Society, Division of Environmental Chemistry, 200th ACS National Meeting, 30 (2), 61-63.

Gilbert, F.I., Minn, C.E., Duncan, R.C., Wilkinson, J. 1990. Effects of Pentachlorophenol and Other Chemical Preservatives on the Health of Wood-Treating Workers in Hawaii, Arch. Environ. Contam. Toxicol. 19, 603-609.

Graham, B.Y., 1979. In Vivo Cytogenetic Studies of Chromated Copper Arsenate Treated Sawdust in Mouse Bone Marrow, Dept. of Chemistry, University of Alabama.

Greaves, H., 1987. Environmental Aspects of Wood Preservation. The International Research Group on Wood Preservation, Document No. IRG/WP/3406.

Heikkila, P.R., Hameila, M., Pyy, L., Raunu, P. 1987. Exposure to Creosote in the Impregnation and Handling of Impregnated Wood, Scand. J. Work Environ. Health, v.13 (5), 431-437.

Henningsson, B., 1983. Environmental Protection and Health Risks in Connection with the Use of Creosote, Holz als Roh und Werkstoff, 41, 471-475.

Hood, R.D., 1979. Evaluation of Chromated Copper Arsenate (CCA) Impregnated in Sawdust for Teratogenicity and Maternal Toxicity in Mice and Rabbits, Dept. of Biology, University of Alabama.

Johanson, R., Dale, F.A. 1973. Arsenic on the Surface of Round Pine Treated with Cu-Cr-As Preservative, Holzforschung Bd. 27 (H.6), 187-189.

Jones, R.D., Winter, D.P., Cooper, A.J., 1986. Adsorption Study of Pentachlorophenol in Persons Working with Wood Preservatives, Human Toxicol., 5, 189-194.

Konasewich, D.E., Henning, F.A. 1988. Wood Preservation Facilities - Recommendations for Design and Operation, Report nos. EPS 2/WP/1, EPS 2/WP/2, EPS 2/WP/3, EPS 2/WP/4, EPS 2/WP/5, Environment Canada, Ottawa, Ontario.

McMahon, C.K., Bush, P.B., Woolson, E.A., 1986. How Much Arsenic is Released when CCA Treated Wood is Burned, Forest Products J., 36(11/12), 45-50.

Naas, D.J., 1988. Primary Eye Irritation Study in Albino Rabbits with NB-110-95-A and Primary Eye Irritation Study in Albino Rabbits with NB-110-95-C, Project Nos. WIL-127005 and WIL-127007, WIL Research Laboratories, Ashland, Ohio.

Ndiokwere, Ch.L., 1985. A Survey of Arsenic Levels in Human Hair and Nails - Exposure of Wood Treatment Factory Employees in Nigeria, Environmental Pollution (Series),9, 95-105.

Peoples, S.A., 1979. The Amount and Valence of Arsenic Excreted in the Urine of Dogs Fed CCA-C in their Diet, Pharmacology Dept., University of California at Davis.

Peoples, S.A., 1979. The Dermal Absorption of Arsenic in Dogs from Sawdust from Wood Treated with ACA and CCA-C, Pharmacology Dept., University of California at Davis.

Saur, J.M., Walcheski, P.J., Gjovik, L. 1983. The Level of Respirable Arsenic on the Surface of Treated Wood in Service, Proceed. Amer. Wood Preservers Assoc., 66-70.

Thind, K.S., Karmali, S., House, R.A., 1991. Occupational Exposure of Electrical Utility Linemen to Pentachlorophenol, Am. Ind. Hyg. Assoc. J., 52(12), 547-552.

Todd, A.S., Timble, M.S., 1983. Industrial Hygiene Surveys of Occupational Exposure to Wood Preserving Chemicals, NIOSH Technical Report No.210-78-0060.

U.S. Consumer Product Safety Commission. 1990. Dislodgeable Arsenic on Playground Equipment Wood and The Estimated Risk of Skin Cancer.

U.S. EPA, 1978. Position Document 1, Wood Preservation Pesticides, Federal Register 48154 (Creosote), 48267 (Arsenic), 48443 (Penta).

U.S. EPA, 1981. Position Document 2/3, Creosote, Inorganic Arsenicals, Pentachlorophenol.

U.S. EPA, 1984. Position Document 4, Wood Preservative Pesticides: Creosote, Pentachlorophenol, Inorganic Arsenicals.

Williams, D.R., Bridges, J.F., 1984. Characterization of Airborne Emissions and Waterborne Drainings Associated with Kiln Drying of CCA-Treated Wood, Proceed. Amer. Wood Preservers Assoc., 224-230.

Williams, D.R., 1983. Evaluation of Arsenically-Treated Wood for Interior Use. Koppers Co. submission to EPA.

Wyllie, J.A., Gabica, J., Benson, W.W., Yoder, J., 1975. Exposure and Contamination of the Air and Employees of a Pentachlorophenol Plant, Idaho - 1972, Pesticides Monitoring Journal, 9(3), 150-153.

Wilson, C.A., 1991. Timber Specialties Ltd. Campbellville, Ontario. Personal communication.

3/ Environmental Impacts of Preservative Treated Wood

3.1/ Introduction

Background Information

Treating wood to prolong its useful life is a widespread practice. Impregnation with a biocide reduces the wood susceptibility to attacks by fungi, insects and marine borers extending its service life 20 to 50 years.

Utility companies (telephone and electricity), railroad and transportation agencies, government departments and private contractors are important users of treated wood. The material they use is treated with heavy-duty chemicals (CCA, ACA, creosote, pentachlorophenol, copper naphthenate) not all of which are available to the general public. However, in the past years, there have been growing concerns about the environmental impact of all treated wood.

These considerations prompted the formation of a working group to gather information on the environmental impact of treated wood. It is composed of representatives of utility companies, railroad and transportation agencies, as well as chemical suppliers, government representatives and technical experts. Participation was voluntary, and the working group had no regulatory mandate. The following document is the result of this committee's work.

Submissions on the topics listed below were solicited from all members of the working groups. The report was assembled by the group coordinator and sent out for comment. Any group with such a diverse membership is bound to have differences of opinion, interpretation and level of understanding of the subject. A consensus report was our goal, however, some unresolved points remain. For example, chemical suppliers and treaters will all agree that there are small, sensitive water bodies that should not receive the run-off from treated wood. An aquatic biologist asks for a definition of "small, sensitive water bodies:" does this refer to pH, use (e.g. fishing, or fish spawning), state of purity, or some other parameters? At this point, readers should note that "sensitive" is used without definition.

Rationale

Given the usefulness of treated wood in societal infrastructure, and the large volume it represents, its environmental impact is worth assessing. Because the biocide treatment is designed to be toxic to wood destroying organisms, concerns that it might have impacts extending beyond its original purpose cannot be ignored.

Over the years, several groups have investigated various aspects of the issue, however, this work has yet to be assessed collectively, with a view towards the logical advancement of research on the topic. The committee's members feel that one should be able to find, in one document, references touching all aspects of the issue, in addition to identifying what data are available from what is missing.

Efforts and resources continue to be allocated to studies of this topic. There is also a need for recommendations on what are the most urgent needs in future research, considering what is already well-documented.

Goal of the Report

The goal of this report is to provide a structured review of available information on all issues relevant to the environmental impacts of the industrial uses of treated wood.

Scope of the Work

To be readily "usable," this review is not intended to be exhaustive. Rather than being a compendium of all available literature on the topic, it will list only the most relevant publications on all topics. Also, the report will address only the primary industrial uses of treated wood (see Table 1), leaving out domestic and secondary uses. This is not intended to be a guide to "recommended uses." Consult the Canadian Standards Association 080 Wood Preservation for more information.

Table 1/ Ongoing primary use applications of preservative treatments in Canada

(* represents current uses)

Primary use	PCP	CCA	ACA	Creosote	CuNap
Poles	*	*		*	*
Ties	*			*	
Lumber		*			
Fence posts	*	*		*	
Bridges/Timbers	*	*	*	*	
Marine Piles			*	*	
Fresh Water Piles	*			*	
Docks		*	*	*	

Some topics were purposely left out of these discussions. These are: the impacts of regulated contaminates (e.g. dioxins) contained in the chemicals used to treat wood, the impacts occurring at the wood treatment facilities, the level of efficiency of the treatment, and all possible impacts of secondary uses or misuses.

Content

The topics addressed in this part of the review are contamination of water, soil and groundwater, and fate of the chemical in the environment. Toxicity is covered in the Health and Safety chapter, and in Appendix III. A review of environmental legislation (Federal and Provincial) governing wood preserving chemicals is attached as Appendix I.

Members of the Working Group agreed that a useful and efficient way of documenting these issues would be to attempt answering questions that are central to the issue of environmental impacts of wood preservatives. Three questions were chosen:

1) What are the in-service losses of preservatives?

2) Under what conditions could the use of treated wood lead to the contamination of the environment?

3) Could the potentially achievable contaminant levels lead to problems in plants, fish, terrestrial animals, birds, or humans?

The answer to the first one focuses on leaching losses and oily exudation ("bleeding"). The second one addresses questions concerning concentrations in environmental matrices such as soil and water, and compares these to existing guidelines and criteria set by various jurisdictions (listed in Appendix I). (It should be noted that the guidelines were formulated based on risks to humans with significant exposure to the contaminated water or soil. It is unlikely that a similar level of exposure could result from the normal use of treated wood.)

The last of the three questions requires an assessment of whether the expected levels of contamination could result in significant impacts on biota, including human foodchain disturbances.

The preservatives are discussed in alphabetical order.

Units

Levels of contaminates in water can be expressed equivalently in mg/L and ppm, and, for lower concentrations, ug/L, ppb and mg/m^3. In soil, the common units are mg/kg, or ppm.

3.2/ Copper Naphthenate

What are the in-service losses of CuNap?

A simulated acid rain study on six Class 5 40' CuNap Lodgepole Pine poles (45 cm section from each pole) subjected to an equivalent of one year's rainfall found that the poles sections lost 4600 mg/m^3 (S.E.= 460 mg/m^3) of copper (Buchanan and Solomon, 1990). Scale-up to a 45' pole predicts about 3000 mg Cu/pole/year run-off due to rainfall leaching. Naphthenate and oil were not measured.

Monitoring a field installation of three of the above poles in an Ontario Hydro test plot gave above ground copper losses (scaled up to a 45' pole) of 3500 - 4100 mg/pole/year and below ground losses (not including butt end axial losses) of 1000 mg/pole/year. Again, naphthenate and oil were not measured (Mortimer, 1991).

Information needs: Above and below ground losses of preservative from a larger sample of treated material, as well as naphthenate and oil losses, over a longer period of time.

Under what conditions could the use of treated wood lead to contamination of the environment?

CuNap treated wood used in water or where run-off enters directly into surface water could result in environmental contamination due to the copper. Guidelines for copper in ambient water are 2 - 4 mg/m^3 of water (Appendix I), compared to the estimated annual loss of 3000 mg per pole. The fate of the naphthenate is unknown.

The oil carrier used on utility poles is mobile and may cause environmental contamination in the case of leaky "bleeder" poles.

Soil concentrations found beside three 45' CuNap poles installed for 3 months had a maximum of 208 mg Cu/kg soil, but at 100 cm from the pole, Cu levels were at background levels, of 20 mg/kg (Mortimer, 1991). Similar values have been found by Grove (1991), with a range of 30 - 2700 mg/kg found after two years (median 690 mg/kg), with background levels of 20 - 370 mg/kg (median 50 mg/kg).

Soil copper levels next to CuNap poles will frequently exceed the guidelines given in Appendix I, 150 - 500 mg/kg. The area extent of this contamination will likely be less than one square metre per pole. The vertical extent is unknown.

Copper is not very mobile in soils at neutral pH, with mobility increasing with increasing acidity. Organic soils can adsorb large amounts of copper.

Information needs: Long-term soil and water impacts (concentrations of copper, naphthenate, and oil) of CuNap treated wood, vertical extent of contamination, butt end losses, larger sample size.

Could the potentially achievable contaminant levels lead to problems in the environment (plants, fish, terrestrial animals, birds, humans)?

Copper toxicity is of little concern to mammals and birds. As the volume of contaminated soil around a piece of treated wood is relatively small, terrestrial ecosystems will not be significantly affected by the copper losses from CuNap treated wood.

Copper is lethal at low doses to aquatic organisms. The most sensitive organism tested was Rainbow trout with an LC50 of 0.25 - 0.69 ppm Cu. *Daphnia magna* LC50 values were 1.1 - 2.7 ppm Cu. Bobwhite quail and Mallard ducks had dietary LC50 values greater than 5620 ppm in the feed (US Army, 1986).

Simulated rainfall leachate, diluted to 10% concentration, from CuNap pole sections caused 50% mortality in *Daphnia magna* (Buchanan and Solomon, 1990). Aquatic systems are considered to be very sensitive to copper.

3.3/ Creosote

What are the in-service losses of Creosote?

It is evident from the depletion of creosote from wood over time that substantial losses occur by various routes, such as leaching, bleeding and volatilization. Measurements of these losses were reviewed by Cooper (1991).

Ingram *et al* (1982) estimated that a 6" diameter x 10' long pile would lose 77000 - 147000 mg/year total PAHs. For all major components of creosote, the pure compound solubility exceeds the drinking water guideline by a factor of hundreds to thousands.

Information needs: Above and below ground losses of preservative from a large sample of treated material, as well as characterization of the lost components, over a period of time. The losses to water bodies of creosote compounds from creosote treated wood used in water need to be characterized.

Under what conditions could the use of creosote treated wood lead to contamination of the environment?

Creosote treated wood used in water or where run-off enters directly into surface water may result in environmental contamination by PAHs, phenolics and BTEX (benzene, toluene, ethyl benzene and xylenes). Guidelines for benzo(a)pyrene (typically specified in regulations) in drinking/ambient/ground water are on the order of 0.1 mg/m^3 of water (Appendix I). The MENVIQ (1989) remediation level is 50 mg total PAHs/m^3 water (50 ppb), compared to the estimated loss from a pile of about 100 g total PAHs, cited above.
Photodegradation of PAHs is an important destruction mechanism in open water and on surfaces, with half-lives from hours to days, but most PAHs are expected to be quite stable in deep, cold, turbid waters and bottom sediments (MOE, 1979).

There are a limited number of studies of creosote concentrations in soils around treated material in land-based applications. Nurmi (1990) found total PAH concentrations of 25,000 - 90,000 mg/kg soil near creosote treated Scots pine poles in service for 10 years, and the poles Nurmi examined were described as bleeding. MENVIQ (1989, see Appendix I) soil guidelines specify remediation at 200 mg/kg total PAH. American regulators determine cleanup criteria on a site by site basis, issuing a Record of Decision detailing the soil and water cleanup levels and the selected remedy to be used. This risk assessment approach may indicate higher action levels are justified, depending on the particular site.

The relative amounts of the many components in creosote can vary from batch to batch. Almost all of these are PAHs and the major ones are consistently the predominant components of typical creosote. There are no data relating toxicity to variations in creosote composition. However, much is known about environmental aspects of PAHs (e.g. MOE, 1979).

Feenstra and Cherry (1990) present calculated dissolved concentrations of many compounds in water in equilibrium with creosote, with the greatest concentrations being of naphthalene (12,730 mg/m^3), benzene, acenaphthene, toluene, fluorene, phenanthrene and anthracene (339 mg/m^3). Benzo(a)pyrene was calculated to be less than 0.08 mg/m^3. As many creosote components have high octanol-water partition coefficients (i.e., are lipophilic), they will partition on to organic matter in soils and their groundwater concentrations would be expected to be less than the above calculated values.

Many creosote compounds (high molecular weight PAHs) are not very mobile in soils at neutral pH, while others (BTEX, low MW PAHs) are quite mobile. Organic soils can adsorb large amounts of creosote. Some biodegradation of low MW PAHs, phenolics and BTEX may occur, under aerobic conditions.

Due to their lipophilicity, many PAHs would be expected to accumulate in sediments and bioconcentrate in aquatic organisms (Dunn and Stich, 1976). There is some evidence that aquatic organisms are able to metabolize and biodegrade PAH compounds and the "...bioaccumulation of PAH is not expected to present nearly as serious a problem as organochlorine pesticides, for instance, as they are metabolized and biodegraded much more efficiently by various strains of bacteria and fish. Nevertheless, this is an area of study requiring further investigation." (MOE, 1979). PAHs in the food chain are from a variety of sources, natural and anthropogenic, and have not been definitively traced to creosote.

Information needs: Long-term air, soil and water impacts of creosote treated wood, characterization of leached material, natural biodegradation rates of creosote compounds.

Could the potentially achievable contaminant levels lead to problems in the environment (plants, fish, terrestrial animals, birds, humans)?

The toxicity and carcinogenicity of the many creosote compounds varies widely, however, no data are available relating toxicity to creosote composition. From the estimates of losses from in-service treated wood, it is not possible to judge the potential environmental hazards of creosote in land-based applications.

In submerged uses of creosoted wood, the high molecular weight PAHs have the potential to accumulate in sediments and aquatic organisms.

Information needs: While the contamination of old wood-treating facilities by creosote is well-documented, very little information is available on the impacts of treated wood in land-based or in water installations, in spite of the long history of use in diverse applications.

3.4/ Inorganic Preservatives - CCA and ACA

What are the in-service losses of CCA/ACA?

Note: In some applications, utility poles in particular, additives such as polyethylene glycol (PEG) are used to improve climbability. These are not expected to affect the leaching of CCA components, as PEG has not been found to affect the efficacy of the CCA treatment (Trumble and Messina, 1987).

Cooper (1991) reviewed the available literature on the leaching losses of CCA components from treated wood in service. In addition to his review, the following results are available, expressed as milligram of copper, chromuim, or arsenic per cubic metre of wood. A study conducted at the University of Guelph involved leaching sections of six Class 5 40' CCA-PEG Red Pine poles (45 cm section from each pole) subjected to a distilled water wash and an equivalent of one year's rainfall of simulated acid rain (Buchanan and Solomon, 1990):

	Simulated Acid Rain Mean (Standard Error) ppb	Distilled Water Wash Mean (Standard Error) ppb	Sum ppb
Cu	7 500 (440)	2830 (630)	10330
Cr	60 (8)	1040 (290)	1100
As	770 (80)	1400 (730)	2170

Scale-up to a 45' pole (0.67 m^3) predicts about 7000 mg Cu, 700 mg Cr and 1500 mg As per pole per year run-off due to rainfall leaching (Mortimer, 1991).

Monitoring a field installation of three of the above poles in a test plot gave total losses, not including butt end axial losses, and scaled up to a 45' pole of:

Cu 440 - 1120 mg/pole/y; Cr 73 - 80 mg/pole/y; As 95 - 182 mg/pole/y.

Water dripping off CCA-C treated boards and poles had measurable levels of CCA components, most were around 0.2 - 5 ppm (Cooper, 1991). The leaching losses were expected to depend on many factors, including wood species and treatment and fixation variables such as temperature, relative humidity, formulation (only CCA-C now used in Canada), age in service, and rainfall conditions.

Laboratory leaching data on ACA indicate that losses are of the same order as those from CCA, with losses of arsenic being slightly higher and losses of copper being lower (Rak and Clarke, 1974; Rak, 1976).

Information needs: A broader range of large samples of treated wood should be monitored for CCA components leaching, under natural conditions.

Under what conditions could the use of treated wood lead to contamination of the environment?

Incomplete fixation is a factor to be considered in predicting short-term environmental contamination from CCA treated wood, but complete fixation occurs eventually, the rate of fixation depending on several factors such as humidity, temperature, etc. The chromium valence state of most concern, Cr(VI), is reduced to Cr(III) during fixation.

CCA treated wood used in water or where run-off enters directly into surface water could result in environmental contamination due to the loss of copper. Guidelines for copper in ambient water are 2 - 4 mg/m^3 (Appendix I), compared to the estimated annual loss of 1000 mg/pole. Guidelines for chromium are 2 - 50 mg/m^3 compared to an estimated annual loss of 80 mg/pole, assuming it is not Cr (VI). Guidelines for arsenic are 50 - 500 mg/m^3 compared to an estimated annual loss of 100 mg/pole. Regarding the aquatic environment, it appears that copper and chromium losses are of more concern than are losses of arsenic from treated wood.

Actual measurements of contamination near treated wood in continual water contact are rare. Langdon and Haley (1988) monitored groundwater near newly installed CCA-PEG poles. They found that during the first week, levels of chromium and copper exceeded those in the control piezometer at three of five sand/gravel monitoring locations, then dropped to background levels by the next sampling date, 10 days later. In one case the allowable limit for drinking water was exceeded (chromium, reached 0.11 mg/L vs 0.01 mg/L background).

Cooper (1991) detected slightly higher levels of Cu, Cr and As in water near both old and new CCA and old creosote treated lock gates. The copper level was found to be above the guideline for aquatic systems at all locations sampled, suggesting that some source other than the treated wood was contributing to these high background levels. The sample size was small and additional data will be collected by Parks Canada. Weis *et al* (1991) claim that significant water contamination can occur, based on laboratory simulation.

Measurements in soil around treated wood in most cases detected significant levels only in the immediate vicinity of structures. Soils near utility poles (30 cm out and 30 cm deep) did not show elevated levels of any of the components (Langdon and Haley, 1988). Except for a few examples (eg, Nurmi, 1990, with CCA-B treated wood), levels in soil are low, of the same order as background levels (Cooper, 1991, Mortimer, 1991). Remediation levels for residential land use of Cu, Cr and As in soils (CCME-NCSRP, 1991, listed in Appendix I) are: for Cu, 100 mg/kg; for (total) Cr, 250 mg/kg and for As, 30 mg/kg.

Increased leaching losses of CCA and ACA components would be expected in warm, acidic, and wet conditions, and in the presence of metal complexing agents such as would be found in silos, bog water, and composters.

Copper is not very mobile in soils at neutral pH, with mobility increasing with increasing acidity. Organic soils can adsorb large amounts of copper. Chromium (VI) is very mobile in soils, so treated wood should be fully fixed before it is placed in service. Arsenic is not mobile in most soils, and the small losses expected should not cause a significant increase above normal background levels.

Information needs: Soil and water around in-service treated wood should be monitored for CCA components for a long time period.

Fixation parameters needing further study include temperature, relative humidity, solution aging, wood species, effects of PEG (or other softening agents).

On-going studies: Bell--University of Toronto study looking at the effect of species, age, location and site characteristics on soil, groundwater and surface water contamination from CCA-PEG poles. In the US, ACA has been replaced by ACZA (ammoniacal copper zinc arsenate) which is not registered in Canada. Forintek is doing a study of leaching of lumber and timbers in playground equipment, which is being funded by Health and Welfare Canada. It is expected to be finished in 1992.
Field tests are planned to evaluate levels in marine waters by Weis *et al* at Rutgers University.

Could the potentially achievable contaminant levels lead to problems in the environment (plants, fish, terrestrial animals, birds, humans)?

Mammalian copper toxicity is of little concern, but copper is lethal at low doses to aquatic organisms. Simulated rainfall leachate, diluted to 2% concentration, caused 50% mortality in *Daphnia magna*

(Buchanan and Solomon, 1990). Aquatic systems are sensitive to copper, and the low levels of CCA/ACA components have been established (see Appendix I) for the protection of all aquatic life.

Unfixed Cr(VI) could contaminate groundwater, although levels would be very low, and would be further reduced to Cr (III) by chemical reduction. Arsenic levels are unlikely to reach hazardous levels in soils.

3.5/ Pentachlorophenol

What are the in-service losses of PCP?

The amount of PCP lost depends greatly on the properties of the solvent and co-solvents, with high boiling fractions retaining preservative longer than low boiling oils (Cooper, 1991).

Ruddick (1990) estimated PCP depletion from in-service wood by plotting retention vs age of treated wood for utility poles up to 30 years of age. He concluded that, "...the amount of pentachlorophenol is lowered during exposure from almost 30 kg/m^3 in the outer 10 mm in red pine poles to less than 1 kg/m^3 after thirty years (Figure 1). Losses at greater depths from the pole surface are lower, but still significant."

This method, with the need to assume a uniform initial retention, inevitably gives highly variable results, and no indication of whether the losses are by volatilization, photodegradation, rainwater leaching or by oil migration.

Results from a University of Guelph simulated rainwater leaching study on six Class 5 40' PCP Red Pine poles (45 cm section from each pole) subjected to an equivalent of one year's simulated rainfall were 13600 mg (S.E.=2640 mg) PCP/m^3 wood (Buchanan, 1991).

Scale-up to a 45' pole predicts about 9150 mg PCP/pole/year in run-off due to rainfall leaching (Mortimer, 1991). Monitoring a field installation of three of the above poles in a test plot gave total estimated annual losses, scaled up to a 45' pole, of 16000 - 111000 mg/pole/year. Butt end axial losses were neither measured, nor estimated.

Information needs: The significance of volatilization, photodegradation, leaching and oil migration (butt end) losses of all the preservative components should be quantified. The rate of loss should be determined over a significant length of time (years to decades).

On-going studies: Hydro-Québec is involved in a major study of the routes by which PCP leaves treated poles, and the fate of the material once it has left the poles. This study includes laboratory, modelling and field aspects.

Under what conditions could the use of treated wood lead to contamination of the environment?

Guidelines for PCP in surface water range from 0.05 - 2 mg PCP/m^3 water in Canada, and 220 mg/m^3 in the US (Appendix I). Estimated annual losses due to rainfall are about 9000 mg/pole/year (Mortimer, 1991). Therefore, treated wood used where run-off enters directly into small, sensitive water bodies could result in environmental contamination.

Photodegradation of PCP in water has been found to occur rapidly under ideal conditions, with the rate depending on latitude, time of day, time of year and light intensity, as well as on the pH and turbidity of the water. For example, Pignatello *et al* (1983) found the 24-hour half-life of PCP to be 3 hours in the top 0.5 cm of the water column, decreasing to 27.5 hours at 10.5 cm depth and to an estimated 129,090 hours at a depth of 50 cm, noting that rates below 13.8 cm were too low to measure accurately.

PCP is mobile in soils at neutral to alkaline pH, with mobility decreasing with increasing acidity (Choi and Aomine, 1974). Organic soils can adsorb large amounts of PCP. Several surveys of soil concentrations near PCP treated utility poles have been conducted (Arsenault, 1976; Canadian utilities including Toner, 1983; Ortiz, 1990; Mortimer 1988, 1991) and soil concentrations next to the poles have been found to vary greatly between poles. The highest concentrations are found immediately adjacent to poles, ranging from as low as background level to a few thousand mg PCP/kg soil. At a distance of 1 m, the surface soil has insignificant levels of PCP. Canadian soil cleanup criteria are typically on the order of 5 mg/kg (Appendix I). US levels are determined for individual sites, based on risk assessment, and are typically higher than the Canadian limits.

Biodegradation and photodegradation are two means by which concentrations of PCP in soils are reduced. Natural biodegradation rates have not been established for the Canadian environment. It is known that the biodegradation rate for PCP depends on many factors including soil moisture content, organic matter content, temperature, pH, the presence of acclimatized bacteria, initial concentration, etc. The half-life has typically been found to be approximately 2 - 4 weeks under favourable conditions (Crosby *et al*, 1981).

Information needs: The extent of PCP contamination of soils around PCP treated poles has been determined in many studies for the top 1 m of soil, and the sharply decreasing concentration vs distance

from the pole profiles have been well-established. The downward migration of PCP has not been adequately addressed, and further surveys are needed to establish the vertical extent of the contaminated zone around treated poles, and possible groundwater impacts. Surface water impacts in the vicinity of PCP treated wood are unknown.

Ongoing studies: EPRI will include PCP treated poles in an extensive survey of utility poles now underway. Vulcan Chemicals (and the US Penta Task Force) are conducting studies to determine photo and biodegradation half-lives. Reports of these studies should be available in 1992.

Could the potentially achievable contaminant levels lead to problems in the environment (plants, fish, terrestrial animals, birds, humans)?

In the aquatic environment, vascular plants exhibit chlorosis at a concentration of about 3 - 4 mg PCP/L (Huber, Schubert and Sautter, 1982). *Daphnia magna* LC50 values are typically between 0.4 and 1.4 mg/L for larvae and adults (Adema and Vink, 1981). Fish sensitivity to PCP is dependent on temperature, pH and dissolved oxygen, with LC50 values typically around 0.05 mg/L (US Dept. of the Interior, 1986). Bobwhite quail and Mallard chicks, 10 days old, had LC50 (5 day diet) values of 3400 and 4500 ppm respectively (US Dept. of the Interior, 1986).

3.6/ Conclusions

Regulatory agencies set recommended maximum soil levels based on human health pathways from the soil to humans (ingestion, inhalation of particles, groundwater contamination and uptake by plants growing in contaminated soils) (Cooper, 1991). One frequently asked question is "Is it safe to eat the garden produce growing next to a treated pole/fence/etc? If we assume that the contamination limits set for agricultural soils were established based on a calculated exposure and a safety margin, it is prudent to advise that if such soil guidelines are exceeded, produce should not be eaten on a regular basis, if at all. It is not our mandate to comment on the soil levels set by regulators. We can state that in virtually all cases examined, the extent of elevated preservative levels did not exceed 1 m from the in-service poles (in the cases reviewed by this committee). In other words, vegetation growing in soil more than 1 m away from a treated pole, for example, is not likely exposed to soil more contaminated than is soil much farther away and not near any poles.

The need for established soil contamination guidelines cannot be denied, but a question of extent must be raised: how large must a zone of contamination be in order for it to be significant?

Treated wood is used in a very dispersed manner, for example, in a line of utility poles. If every one of Ontario's 1.5 million poles contaminated a zone of one square metre of soil (a likely over-estimate) to an extent exceeding the provincial soil guidelines, the total area would be only 150 hectares, of the 1 million hectares that is the area of Ontario. Compared to the overall benefits of using treated wood utility poles, this overall "cost" may not be very significant. Individual treated wood installations, however, do need to be considered, as the characteristics of the wood and of the site can be expected to show large variations, and we need to ask if there may be some cases where the conditions result in significant environmental contamination.

3.7/ Recommendations

Research

Canadian electric utilities in Alberta, Ontario and the Maritimes are installing CuNap poles on a trial basis. These utilities should be encouraged to monitor losses from these poles by testing adjacent soil for copper naphthenate and oil.

Canadian electric utilities purchase little, if any, creosote-treated poles, although "clean creosote" is receiving some attention. Railways and transportation agencies constitute the majority users of creosote-treated wood. It is recommended that they undertake to investigate the environmental impact of this use, beginning with monitoring losses from creosote-treated wood products in service.

The effect of CCA (plus additives) fixation parameters on long and short-term leachability should be investigated further.

On-going surveys of soil and water near wood products in service should be carried out by users of treated wood.

Measurement of the naturally occurring degradation by light and by microorganisms of pentachlorophenol and creosote, as a function of time, concentration and environmental parameters (temperature, light intensity, soil biological activity, etc) should be determined, for Canadian environmental conditions.

Losses of PCP and creosote from treated wood due to volatilization should be investigated.
The vertical extent of the contaminated zone around PCP-treated poles will be addressed to some extent by the proposed EPRI study. This work should be monitored to determine if our needs will be met by their investigations.

Uses

Copper naphthenate treated wood will not likely have serious environmental impacts when used in land-based installations such as poles, ties and posts, but it is not recommended for use where run-off (oil or water) can enter sensitive aquatic environments.

Copper naphthenate currently is not recommended for marine applications until further testing (now underway) is finished.

Creosote treated wood will likely have limited environmental impacts when used in land-based installations such as ties and posts, although monitoring is recommended to establish its losses.

The use of creosote-treated wood in water, such as for pilings in sensitive water bodies, should be reviewed.

With CCA-(PEG) it is necessary to ensure that wood is properly fixed. If not, it should be rejected by the purchaser.

CCA treated wood should not be used in acid bog, silo or composter applications, as accelerated leaching may lead to accelerated deterioration of structures and adverse effects on aquatic life.

Pentachlorophenol should not to be used near sensitive water bodies, where run-off (oil or water) can enter aquatic environments that could be adversely affected.

All oil-treated wood that is not bleeding can be used for bridges and decking material, if the structure is properly designed to prevent the preservative adversely affecting the water.

"Bleeder" material should be rejected by purchasers. Production of such material should be avoided.

3.8/ References

Arsenault, R.A., 1976. Pentachlorophenol and contained chlorinated dibenzodioxins in the environment. Proc. AWPA 20:122-148.

Buchanan, R.D., 1991. Persistence, leaching and availability of chromated copper arsenate polyethylene glycol, copper naphthenate and pentachlorophenol wood preservatives from pressure treated utility poles. M.Sc. Thesis, University of Guelph.

Buchanan, R.D, and K.R. Solomon, 1990. Leaching of CCA-PEG and CuNap wood preservatives from pressure treated utility poles and its associated toxicity to the zooplankton *Daphnia magna*, Proc. of the Canadian Wood Preservation Association 11:130-143.

Choi, J. and S. Aomine, 1974. Adsorption of pentachlorophenol by soils. Soil Sci. Plant Nutr.20:135-144.

Cooper, P.A., 1991. Leaching of wood preservatives from treated wood in service. Public Works Canada, Ministry of Supply and Services Canada, Cat. No. W63-22/1991E.

Crosby, D.F., K.I. Beynon, P.A. Greve, F. Korte, G.G, Still and J.W. Vouk, 1981. Environmental chemistry of pentachlorophenol. Pure Appl. Chem. 53:1051-1080.

Dunn, B.P., and H.F. Stich, 1976. Release of the carcinogen benzo(a)pyrene from environmentally contaminated mussels. Bull. Env. Contam. and Toxicol. 15(4):398-401.

Feenstra, S., and J.A. Cherry, 1990. Groundwater contamination by creosote. Proc. CWPA 11:214-236.

Grove, S., 1991. Memo to W. Mortimer from Mooney Chemicals, Inc., October 14, 1991, Mooney Chemicals, Inc. Laboratory Memorandum No. 3601 appended.

Huber, W., V. Schubert and C. Sautter, 1982. Effects of pentachlorophenol on the metabolism of the aquatic macrophytic *Lemna minor*. Environ. Pollut. (A) 29:215-224.

Ingram, L.L., Jr., G.D. McGinnis, L.R. Gjovic, and G. Roberson, 1982. Migration of creosote and its components from treated piling sections in a marine environment. Proc. AWPA 78:120-128.

Langdon, R.E. and D.S. Haley, 1988. Environmental Monitoring of CCA-PEG treated Distribution Poles. NSPC Report 88-SS-1.

MOE, 1979. Ontario Ministry of the Environment ARB-TDA Report No. 58-79.

Mortimer, W.P., 1988. Environmental persistence and migration of pentachlorophenol, wood pole preservative Part I: literature review. Ontario Hydro Report No. 88-248-K.

Mortimer, W.P., 1991. Environmental persistence and migration of wood preservatives, Canadian Electrical Association Report 118-D-697.

Nurmi, A.J., 1990. Leachability of active ingredients from some CCA treated and creosoted poles in service. Int. Res. Group on Wood Preserv. Doc. IRG/WP/3627.

Ortiz, W., 1990. Pentachlorophenol Migration Pole to Soil. Manitoba Hydro Report 584-39(1.1).

Pignatello, J.J., M.M. Martinson, J.G. Steiert, R.E. Carlson and R.L. Crawford, 1983. Biodegradation and photolysis of pentachlorophenol in artificial freshwater streams. Appl. Environ. Microbiol. 46:1024-1031.

Rak, J., 1976. Leaching of toxic elements from spruce treated with ammoniacal solutions of copper-zinc-arsenic preservatives. Wood Sci. Technol.10:47-56.

Rak, J.R. and M.R. Clarke, 1974. Leachability of new water-borne preservative systems for difficult-to-treat wood products. AWPA 70:27-34.

Richardson, N.G., 1991. Memo to W. Mortimer from Domtar, Inc. Dec. 6, 1991.

Ruddick, J.N.R., 1990. Wood preservation and the environment. Proc. CWPA 11:115-129.

Toner, T.P., 1985. Pentachlorophenol Use in NSPC Pole Retreatment Program. Nova Scotia Power Corporation Report 83-EP-2 and annual updates, Report on Pentachlorophenol Monitoring Program Updates (85-HS-3 and 86-SS-2).

Trumble, W. and E. Messina, 1987. CCA-PEG pole preservative research. CWPA 8:85-95.

U.S. Army, 1986. Environmental Hygiene Agency, Phase II. Preliminary assessment of relative toxicity of copper naphthenate. Report 75-51-0497-88.

U.S. Department of the Interior, 1986. Manual of acute toxicity. Resource Pub. 160.

Vulcan Chemicals, 1991. Pentachlorophenol in Perspective: A Summary Report.

Weis, P., J.S. Weis and L.M. Coohill, 1991. Toxicity of estuarine organisms of leachates from chromated copper arsenate treated wood. Arch. Environ. Contam. Toxicol. 20:118-124.

4/ Disposal of Preservative Treated Wood

4.1/ Disposal

Working group III was established to consider the challenge of management of solid treated wood waste generated by removal of treated wood from service. Large quantities of wood treated with pentachlorophenol, creosote, chromated copper arsenate or ammoniacal copper arsenate are removed from service each year as a result of in service failure or redundancy of the structure. There is increasing concern about the environmental consequences of various waste management options for this material. These consequences depend on the amounts of treated wood removed, the amounts of residual preservative in the wood and the persistence of the preservative in the wood. In this report, we present estimates for these factors and try to identify some of the knowledge gaps relevant to the disposal of treated wood.

4.2/ Quantities of Treated Wood Removed from Service

Cooper and Ung (1989) estimated the amounts of various products and preservatives removed from service annually. Where possible, these numbers have been updated and refined. The amounts of preservative in wood removed from service are estimated on the basis of quantities of products removed from service, assumed initial retentions (= CSA recommended loadings) and estimates of depletion of preservatives from wood in service. Where this information is not available, historical data on preservative consumption in Canada are used with assumed average service lives of treated products and estimates of residual preservative in products. The data are very approximate and should only be used as a rough guide to quantify the problem.

An estimated 230,000 poles are removed from service each year, in Canada, representing a wood volume of about 180,000 m^3. Most are penta treated, but an undetermined number are creosote or CCA/ACA treated. Since many older poles are butt-treated cedar, estimates based on full pole volumes overestimate quantities of treated wood. The values in Table 1 assume that most removed poles are full-length penta treated, and therefore overestimate actual quantities. Analysis of penta treated poles removed from service (Ruddick, 1990) suggest that considerably more than 50 % of the penta may be lost by the time the pole is removed from service. In the future, quantities of creosoted poles removed will decrease as remaining creosoted poles are removed and quantities of waterborne treated poles will increase reflecting the changing preservative use patterns.

About 3,000,000 railway ties are taken out of service each year in Canada, representing about 475,000 m^3. More than 90% are treated with creosote/petroleum and the remainder with penta-in-oil. We were not able to find any studies on the loss of creosote from railway ties in service. The authors assume that 25% of the preservative is lost over the 20-25 year service life as a result of bleeding, evaporation or leaching. Future quantities are expected to stabilize at about 2,000,000 ties per year as unused lines are taken out and tie maintenance programs are improved.

Estimated quantities of treated bridges and guiderail posts removed are based on a recent survey of provincial highways departments (R. Taylor, 1991 personal Communication). The quantities are scaled up to account for non-respondants.

CCA treated wood for disposal consists mainly of construction off-cuts and residential structures (fences and decks) dismantled by homeowners. Current volumes are small but will increase exponentially over the next 10 - 20 years, reflecting the rapid growth in use since 1975 and increased use of this treatment for poles and other products.

Using the same types of analyses, the estimated amounts of treated wood removed in the USA are about 8.2×10^6 m^3 of which, 1.4×10^6 m^3 is from penta treated poles (Nowak 1991, personal communication). This latter number corresponds to about 2.1×10^6 penta treated poles per year.

Table 2/ Estimates of treated wood and entrained preservative removed from service in Canada

Product	Preservative	Initial Loading (kg/m^3)	Volumes Units $\times 10^6$	Volumes Vol. $m^3 \times 10^3$	Losses In Situ %	Residual Chemical (Tonnes)
Railway ties	Creosote/oil 50/50	64/64	2.7	250	25	16000/16000
	Penta	8	0.28	25	25	150
Poles	Penta	8	0.20	150	50	600
	Creosote	128	?	?	50	?
	CCA/ACA	6.4	?	?	5	?
Bridges, pilings, posts etc.	Creosote	128	—	45	25	4320
	Penta	8	—	10	25	60
	CCA/ACA	6.4	—	low	low	low
Residential construction	CCA/ACA (new)	4.0	—	50	0	200
	(old)	4.0	—	20	10	70
Window joinery	PMO	—	—	40	—	—

4.3/ Options for Waste Management of Treated Wood

Landfill Disposal

Landfill disposal of treated wood is usually regulated on the basis of leaching characteristics of the wood, as determined by a standard leaching procedure e.g., TCLP. Unfortunately, the criteria for these leaching procedures vary between the U.S.A. and Canada, and among Canadian provinces. Furthermore, the criteria are constantly changing as regulatory status of the active ingredients changes. Some jurisdictions prohibit landfill disposal of treated wood under different regulations e.g., Sask. "Municipal Refuse Management Regulation, 1986.

TCLP tests on creosoted railway ties in the USA show that even new ties meet the criteria for landfill disposal by the EPA mandated procedure.

Similarly, penta treated poles meet their criteria for pentachlorophenol (EPRI 1989). However, by current Québec standards for oil and grease and total dioxins, penta treated poles do not consistently meet the TCLP requirements (Boire & Millette, 1991, Personal Communication).

CCA treated wood meets the EP Toxicity (older version of the TCLP test) criteria (McNamara 1982) by a large margin. Based on these tests, normal landfill disposal is still the recommended disposal method for CCA treated residential lumber off-cuts and demolition wood.

It is generally the consensus of the Working Group that recycling or reuse of treated wood are the preferred approaches, with landfill disposal being the next most viable option - particularly in view of the current negative attitudes towards incineration in Canada.

For disposal of small volumes of treated wood, the recommendations in CITW documents and U.S. Consumer Information Sheets are appropriate. They recommend using ordinary trash collection or burial, and state that treated wood should not be burned.

Reuse of Treated Wood

Reuse is extensively practiced by major generators of decommissioned treated wood such as Utilities and Railway companies. Internal reuse for pole stubs, anchors, low service poles or ties, right-of-way fence posts etc. is the most desirable option. Reuse by farmers, landscapers, small contractors etc. may carry some liability problems for the original generator. Most Utilities have developed waiver-of-responsibility forms that must be signed by receivers of decommissioned wood.

Butt treated poles and thin sapwood treated poles may be sawed again to recover the untreated portions for other uses. The main problem will be disposal of the treated portions and generation of contaminated sawdust.

One reuse opportunity identified by this Working Group is the use of poles removed by Utilities as guiderail posts by Provincial Transport Ministries (e.g. MTO). Questions that must be answered are:

Are the pole dimensions compatible with the MTO requirements? Do the recut poles need retreatment, and if so, with what? What problems develop from recutting the poles for another use?

Waste CCA treated wood is mainly off-cuts from construction at this time. In municipalities with wood recycling facilities, such as WCI in Brampton, There is an opportunity to reuse some of this material for shims, deck bracing, post caps, patio wood slabs, planter boxes etc. Information is needed on the quantities of this wood available and its size distribution.

Recycling of Treated Wood

There are a number of initiatives in Canada (Bell Canada/ UBC, Ont. Hydro/U of T/ U. of Waterloo, and Hydro Québec) and elsewhere to recycle penta treated poles by extracting and recycling or biologically breaking down penta from comminuted wood. The Canadian studies are still at an early stage. A process developed at Louisiana State U., is claimed to decontaminate chips from treated poles in about 3 months, at a cost of $100 - 200 per pole (Anon 1991b). Some of the unanswered questions are: What are the residual levels in processed wood? Are these levels acceptable for pulping and other recycling options for the processed wood? Is the penta completely mineralized to CO_2 and H_2O by the biological agents or converted to other, possibly toxic by-products such as anisoles.

Some technology exists for reconstitution of chipped treated wood (e.g., Cedrite process for composite railway ties from used ties). Scientists at the University of Toronto and elsewhere are successfully extending polymeric materials with waste wood. It is conceivable that waste treated wood could be used for this purpose to produce wood plastic composites for exterior applications. Studies on compatibility of treated wood and plastics, properties of such composites, leachability of preservatives and recyclability of the composite product are needed to test the feasibility of this approach. Similarly, treated wood/concrete composites are of interest e.g., for highway sound barriers.

Combustion/Incineration of Treated Wood

Incineration of penta and creosote treated wood at co-generation facilities and cement kiln facilities is an accepted means of recovering some value from waste treated wood in the U.S.A. (e.g., Anon 1990). As long as the flame temperature and retention times in the flame are high enough, both preservatives decompose to innocuous by-products. Burning of old creosote treated wood is not unlike burning coal, and the technology for destroying chlorinated organics by incineration is well established and technically sound. However, in Canada, the regulatory climate and public perceptions are major obstacles to what would otherwise be a viable disposal option. It is difficult to get permits to burn treated wood except at registered toxic waste disposal facilities, such as the Swan Hills, Alberta toxic waste facility.

Incineration of inorganic treated material is more of a problem since the preservative itself cannot be destroyed. Arsenic would have to be removed from the flue gases and ash would contain preservative elements (Dobbs and Grant 1976, McMahon et al 1986). It seems unlikely that incineration could be a viable option for wood treated with inorganic wood preservatives.

Legislative Considerations

Technically, in B.C., Penta treated wood may be considered "Special Waste" under the B.C. Special Waste Regulation 1988, because it contains > 1000 mg/kg halogenated organic compounds. This designation requires sophisticated disposal methods. Under the Transport of Dangerous Goods Act, CCA treated products qualify as Special Wastes because they contain more than 100 ppm of hazardous chemicals e.g., arsenic. However, at this time treated wood is generally explicitly excluded from these classifications.

In the U.S.A., a current proposal for drinking water by the EPA would upgrade penta from a "possible carcinogen" to a "probable carcinogen". This would result in revision of the current maximum allowable concentration of penta in drinking water from 0.2 mg/l to 0.001 mg/l (Anon 1991). Since the toxicity characteristic values used to classify solid materials are based on drinking water standards, this would place penta treated wood in the hazardous waste category at an added annual cost for handling and disposal of $ 2.5-7 Billion (Anon 1991).

Other Factors

It must also be recognised that the quantities and environmental significance of treated wood can also be affected by other strategies or developments that are not normally considered as waste management options. Examples include:

- Reduction of waste generated by extending the service life of products in service through in situ treatments such as with borate rods or bandage treatments.

- Ensuring extended service lives by assuring adequate quality of treatment by technological innovations such as double density incising or by standards enforcement through third party inspection programs (e.g., CWPB).

- Use less toxic preservatives where the decay hazard and the consequences of failure are low. An example would be use of a copper chromate or ammoniacal copper preservative for fence boards. Use lower toxicity preservatives such as copper naphthenate where appropriate.

4.4/ Hierarchy of Waste Management Options

Cooper and Ung (1989) presented a hierarchy of waste management for three major wood preservatives (Tables 2,3 & 4). While some of the rankings and options may have changed this hierarchy is generally endorsed by the Working Group.

4.5/ Recommendations

(i) Since there is a shortage of reliable information on the amounts of treated wood removed from service each year, we recommend that a detailed study be undertaken to develop this information, particularly for the major uses of treated wood, such as poles, piling, ties, bridge and guiderail timbers and residential construction. One approach is to recommend to Environment Canada that the Report on Disposal of Treated Wood be periodically updated to include more recent disposal data in Canada, technological developments here and abroad and changes in relevant environmental legislation. Also, Environment Canada should publish the report for more widespread access.

(ii) A study should be undertaken to explore the feasibility of reusing utility poles as guiderail posts and other products. The study would include determination of quantities of

decommissioned poles and their quality characteristics, recommendations re retreatment, etc. Prior to publication of this document MTO and Bell Canada initiated a research project, in February 1992, to evaluate this consideration.

(iii) The feasibility of incorporating comminuted treated wood in wood plastic and wood/cement composites should be investigated.

(iv) Evaluation of field treatments should be extended to solid wood products other than the currently evaluated poles and ties.

4.6/ References

Ahling, B. 1979. Destruction of chlorinated hydrocarbons in a cement kiln. Environmental Science and Technology. 13(11):1377-1379.

Andrews, S.M., S.N. Bruce and P. O'Brian. 1955. Distribution and composition of creosote in a pole that has been in service for twenty-three years. Proc. Amer. Wood Preserv. Assoc. 51:66-74.

Anon. 1991a. Drinking water wood preservative proposal could make utility poles hazardous. Inside EPA, May 24, 1991.

Anon, 1991b. Microbes will recycle toxic wood utility poles. Engineering News Record. 227(11):12.

Anon. 1990. Crosstie disposal - Cogeneration benefits at Koppers. Crossties. July/August:16-18.

Cooper, P.A. and T. Ung. 1989. Assessment of preserved wood disposal practices. Environment Canada Conservation and Protection Report. (Draft).

Dobbs, A.J. and C. Grant. 1976. Report on the burning of wood treated with wood preservatives containing copper, chromium and arsenic. Building Research Establishment Paper CP 63/76. Princes Risborough Lab. Aylesbury, U.K.

Hockensmith, E.H., M.L. Linn and J.E. Waggener. 1988. Toxicity characteristic leaching procedure testing of railroad crossties. Report R-708 to The Association of American Railroads.

McMahon, C.K., P.B. Bush and E.A. Woolsen. 1986. How much arsenic is released when CCA treated wood is burned? Forest Prod. J. 36(11/12):45-50.

McNamara, W.S. 1982. A potpourri of work in the treatment of lumber and plywood. Proc. Can. Wood Preserv. Assoc. 3:35-43.

Ruddick, J.N.R. 1990. Wood preservatives and the environment - A Canadian perspective. Proc. Can. Wood Preserv. Assoc. 11:115-129.

Table 3/ Relative rating of economic and social costs or benefits for various waste management options - Creosote treated products

Waste Management Option	Railway Ties		All Other Products	
	economic	social	economic	social
Reuse as lower grade products @	+++	++	++	++
In situ treatments @	++?	++?	++	++
Technological innovations	++?	++?	++?@	++?
Recycle as landscape timbers, fence posts etc. @	++	-+?	++	-+?
Controlled incineration for energy	++	+	+	+
Chip and reconstitute for ties and other products @	+?	+?	+?	+?
Burn at removal site	-	–	-	–?
Leave in service or at removal site	-	—	-	—
Landfill disposal	—	-	–	-
Burn at registered hazardous waste facility	—*	-	—*	-

+: benefit (++++:very high benefit, etc.)

-: cost (-: low cost, etc.)

*: unacceptable cost

@: limited applicability

?: more research or study needed

Table 4/ Relative rating of economic and social costs or benefits for various waste management options - Pentachlorophenol treated products

Waste Management Option	Utility Poles		All Other Products	
	economic	social	economic	social
Reuse as lower grade products @	+++	++	++	++
In situ treatments @	+++	+	+?@	+?@
Technological innovations	++?	++?	+?@	+?
Recycle as landscape timbers, fence posts etc. @	++	+?	++	+?
Controlled incineration for energy	+?	+?	+?@	+?
Chip and reconstitute for ties and other products @	+?	+?	+?	+?
Burn at removal site	-	—	-	—
Leave in service or at removal site	-	—	-	—
Landfill disposal	—	-	—	-
Burn at registered hazardous waste facility	—*	-	—*	-

+: benefit (++++:very high benefit, etc.)

-: cost (-: low cost, etc.)

*: unacceptable cost

@: limited applicability

?: more research or study needed

Table 5/ Relative rating of economic and social costs or benefits for various waste management options - CCA and ACA treated products

Waste Management Option	Residential Construction		All Other Products	
	economic	social	economic	social
Reuse as lower grade products @	+++	++	++	++
In situ treatments @	n.a.	n.a.	++	++
Technological innovations	++?	++?	++?	++?
Recycle as landscape timbers, fence posts etc. @	+@	++	++	++
Controlled incineration for energy	++	–	+	–
Chip and reconstitute for ties and other products @	+?	+?	+?	+?
Leave in service or at removal site	-	–	-	–
Landfill disposal	—	-	–	-
Burn at registered hazardous waste facility	__*	-	__*	-

+: benefit (++++:very high benefit, etc.)

-: cost (-: low cost, etc.)

*: unacceptable cost

@: limited applicability

?: more research or study needed

5/ Value Assessment of Preservative Treated Wood

5.1/ Introduction

The value of the pressure treated wood industry and its products in Canadian society is recognized as being considerable. However, proper qualification of these values has never been undertaken.

Available data are incomplete, usually dated and often from other countries. A great deal of this information is proprietary to producers and users and for legal and/or business reasons is unavailable.

5.2/ The Value of Wood Preservation

Wood preservation provides Canadians with economic, societal and environmental benefits.

The wood preservation industry provides employment through a large network of raw material suppliers; producers; distributors; retailers; builders; industrial, commercial and residential users.

Wood preservation provides products which serve our society in many ways. Poles for telecommunications and power distribution, railway ties and bridge timbers for transportation, lumber for decks, fences and playground structures are but a small sampling of the many important uses of these products.

Wood preservation has shown through controlled studies to enhance the service life of wood products by a factor of 5 to 15, depending on the wood species, use and efficacy. A direct result is reduced demand upon one of our most important natural resources, the forest.

5.3/ Existing Information

The Value Assessment Working Group, with members from industry and user groups, was only successful in obtaining very general information about the value of treated wood products. Articles such as those printed in Modern Railroads and Railway Track & Structures make only general reference to the cost of using alternative materials and focus more on technology.

The Rebuttable Presumption Against Registration (RPAR) process conducted in the United States by the Environmental Protection Agency in the 1980's resulted in a need for a comprehensive assessment in that country.

In 1977, a comprehensive evaluation entitled "Economic, Social and Environmental Benefits From the Use of Wood Preservatives" was prepared for the American Wood Preservers Institute, by H.R. Josephson, Consulting Forest Economist. The analysis contained in the paper focussed on the potential impacts of the cancellation of wood preservatives on users of these substances and on consumers of treated wood products. The Summary and Conclusions section of this paper follows:

1. The wood preserving industry in the United States is based essentially on the use of the three major pesticides, creosote and its solutions, pentachlorophenol and arsenical compounds. About 400 wood treating plants employ more than 11,000 workers in providing services valued in excess of $175 million annually. The volume of wood products given preservative treatment in 1974 totalled 275 million cubic feet, representing over 6 percent of the annual product of lumber and 20 percent of the round timber products obtained from U.S. forests.

2. Creosote compounds were used in treating over half of all products given preservative treatment in 1974 even through use of creosote has declined since the 1940's along with a corresponding rise in use of pentachlorophenol and arsenical compounds. Nearly all wood railway ties and wood piling and substantial portions of the poles and fence posts treated in 1974 were given preservative treatment with creosote. Pentachlorophenol was used in treating about 28 percent of the total -- mainly poles and lumber. Arsenicals were used for about 16 percent of the total -- mainly lumber.

3. Economic benefits to consumers of treated wood products amount to an estimated $4.5 billion annually. Treated wood products have many times the life of untreated wood materials, and in many applications have substantial advantages over non-wood products in terms of cost and performance. Use of treated wood railway ties, for example, entails estimated savings of roughly $2.7 billion annually over use of untreated ties, and $1.3 billion annually over use of concrete ties. Use of treated utility poles saves utilities and utility customers an estimated $3.0 billion annually. Savings to users of other treated products such as lumber, piling and fence posts total additional millions of dollars each year.

4. Conservation benefits from preservative treatment of wood products are also of far reaching importance. Use of treated wood permits lower timber harvests than otherwise needed, with consequent lower prices to the consumers, increased timber supplies for future generations, and greater availability of forest land for recreationists and other non-timber users. Forests also

are uniquely renewable and can furnish greatly increased supplies of timber products with intensified forest practices and efficient use of available timber supplies.

5. If use of wood preservatives were cancelled or restricted, non-wood materials such as steel, concrete and aluminium would undoubtedly be substituted for treated wood products. But this would necessitate higher costs in applications where treated wood is now used, considerably higher energy requirements in the processing of materials, greater air and water pollution and/or environmental protection costs, a high degree of dependence on foreign sources for imported materials, and use of resources that are non-renewable. These varied and adverse impacts would be widely felt throughout the U.S. economy.

6. Restrictions on use of wood preservatives would also have serious impacts on the wood preserving industry, suppliers of timber products, and on the many communities, mostly rural, that are supported by wood preservation activities. Many thousands of workers and hundreds of communities would be seriously affected by loss of jobs, loss of plant investments and loss of social capital in affected communities.

7. Substitution of one preservative for another is possible in many, but not all cases. Each of the major preservatives is preferred for particular types and uses of materials, reflecting a balance of factors such as service life, relative costs, or properties of treated wood. A ban on use of any of the major preservatives would have adverse affects on both users of treated products and on the wood treating industry.

8. If creosote were not available, pentachlorophenol and arsenicals could be substituted in treatment of most products, but such substitution would require substantial investments for new chemical plants, adjustments in equipment and operating practices in the wood treating industry, many uncertainties as to service life and ultimate costs in using treated materials such as railway ties and piling and uncertainties as to availability of heavy oil for use with pentachlorophenol.

9. If pentachlorophenol were unavailable, either creosote or arsenicals would be technically suitable for treatment of most products although with some uncertainties as to chemical supplies, costs, and adjustments in equipment and operating practices in the wood treating industry.

10. If arsenicals were not available, pentachlorophenol or creosote could be used for treatment of poles, posts and some lumber items. However, for many uses of treated lumber, and piling in certain marine environments, no satisfactory alternative preservatives are available.

In general, the conclusions expressed by AWPI might be applicable in Canada bearing in mind different economic scales, etc.
It should be noted that this information is almost 20 years old and the treated wood industry has grown significantly in that time span. Residential use products have shown phenomenal increases in volume thereby encompassing a larger spectrum of stakeholders with greater economic impact.

5.4/ Recommendations

The Value Assessment Working Group of the Task Force on Preservative Treated Wood recognizes the need for a comprehensive economic benefit assessment for pressure treated wood products. The impending announcement by Agriculture Canada (expected in Spring 1992) of a registration review for wood preservatives places a great deal of emphasis on the need to determine the value of treated wood products in the Canadian economy. Currently available information is primarily of U.S. origin, in some cases very product specific, and often dated.

To provide a better understanding of the importance of these products for Canadians, the Working Group recommends that an economic benefit assessment be commissioned with the cooperation of manufacturers and users of the products. A suggested list of contents follows:

Section	1.0	Introduction
Section	2.0	The Canadian Pressure Treating Industry
	2.1	Overview
	2.2	Pressure Treating Operation
	2.3	Chemical Suppliers - Wood Preservatives
	2.4	The Importance of Wood Preservation
Section	3.0	Pressure Treatment Wood Preservatives and Applications Methods
	3.1	Past Practices

	3.2	Application Methods
	3.3	Presently Used Wood Preservatives
	3.4	Comparisons of Efficacy
Section	4.0	Markets for Canadian Pressure Treated Wood Products
	4.1	Industrial/Commercial
	4.2	Residential/Consumer
	4.3	Import/Export
Section	5.0	Benefit Analysis of Pressure Treatment Wood Preservative Use
	5.1	Analytical Approach
	5.2	Determination of Total Value of Products at Risk
	5.3	Potential Loss and Impact on Industry
	5.4	Potential Loss and Impact on Users
	5.5	Summary
Section	6.0	Benefits of Pressure Treated Wood Products vs. Alternatives
Section	7.0	Summary and Discussion

An assessment of this kind is necessary and will become an essential aspect of the re-evaluation of wood preservatives to be announced by Agriculture Canada.

5.5/ References

Chancellor, A., April 1989. To Buy or Not to Buy? That's the Question. Modern Railroads

Josephson, H.R., 1977. Economic, Social and Environmental Benefits From the Use of Wood Preservatives. American Wood Preservers Institute, Vienna, VA

Maffet, D.C., March 1980. The Timber Tie: Today's Sandby, Adaptable for Future. Railway Track and Structures

Rebuttal Presumption Against Registration, 1978. United Stated Environmental Protection Agency, Washington, DC

Tie Technologies, Testing, Treatment, October 1990. Modern Railroads

Appendix I

A/ Summary of Legislation: Wood Preservative Chemicals

This section describes the principal federal and provincial legislation (Acts and Regulations) which addresses the use, transportation, and disposal of wood preservative chemicals.

Federal

1. Fisheries Act: Provides authority to review plans for operations, recommend modifications and, prohibit construction; prohibit the discharge of deleterious substances into waterways frequented by fish.

2. Canadian Environmental Protection Act: Provides authority to investigate and collect information on commercial chemicals pertaining to all facts of production, use, and release into the environment; develop regulations prescribing the maximum quantity of a substance which may be released and the conditions under which the substance may not be imported, manufactured, processed, offered for sale or used.

3. Pest Control Products Act and Regulations: The Act regulates produce use; and prescribes product registration procedures with Agriculture Canada.

4. Ocean Dumping Control Act & Regulation: Provides the authority to restrict the dumping of scheduled substances into ocean waters.

5. Transportation of Dangerous Goods Act and Regulations: Regulations for documentation (manifests and waybills), packaging and labelling for nine classes of dangerous goods and wastes.

6. Clean Air Act: An Act relating to ambient air quality and the control of air pollution.

Provincial

Alberta

1. Clean Water Act: Provides the legislative basis for the protection of surface and groundwater.

2. Clean Air Act: Provides legislative basis for the protection of ambient air quality and control of air pollution.

3. Hazardous Chemicals Act & Hazardous Waste Regulations: The disposal of hazardous waste is controlled under these acts and regulations.

Québec

1. Loi sur la qualité de l'environment (Environmental Protection Act): Prohibit the emission, dispose and release of contaminants (a solid liquid or gas, or any combination of these) that could alter the quality of the environment.

2. Loi sur la sante et la sécurité du travail (Occupational Health and Safety Commission): This Act prescribes the mechanisms on how to prevent accident and occupational illness of workers and employers in the workplace.

3. Code de la sécurité (Highway Safety Code): This regulation protects the public during the transport of dangerous goods. Documentation, packing, and signing for dangerous goods are specified.

Saskatchewan

The province has no legislation specific to the use and disposal of wood preservative chemicals. The uncontrolled release of preservative chemicals is reportable under the Environmental Spill Control Regulations. Disposal in municipal landfills is prohibited by the Municipal Refuse Management Regulations. Dangerous Goods Trans- portation Regulations, Hazardous Substance and Industrial and Hazardous Waste Management Regulations address the transportation, storage, treatment and disposal of the wastes.

British Columbia

1. Waste Management Act: Provides the legislative basis for overall management of industrial wastes for the protection of the environment; provides the authority to issue permit to discharge, store, transport wastes, and prepare contingency plan.

2. Environmental Management: Prescribes procedures for environmental emergency and recovery of costs associated with it.

3. Pesticide Control Act and Regulations: Provides the direction how the pesticides should be sold and used safely so that there are no adverse affects to the environment.

4. Workers' Compensation Act Industrial Health and Safety Regulations: Provides direction for prevention of injuries and industrial diseases to workers at their place of employment.

Manitoba

1. Dangerous Goods Handling and Transportation Act and Regulations: The legislative basis covering all aspects of handling dangerous goods including their manufacture, use, storage, transportation and disposal.

2. Clean Environment Act and Regulations: Environment and workplace safety and health.

Ontario

1. Dangerous Goods Transportation Act: Enact regulations to supplement those promulgated under the Federal Transportation of Dangerous Goods Act.

2. Environmental Protection Act: The Act provides the legislative basis for the protection of the environment.

3. Health Protection and Promotion Act: Provides authority to inspect, receive complaints and issue orders for health hazard related issues.

4. Lakes and Rivers Improvement Act: Provides direction for the protection of water bodies and for their equitable public and private use.

5. Pesticides Act: Regulates all use and handling of wood preservatives.

6. Occupational Health and Safety Act: Governs protection of health and safety in the workplace.

B/ Regulatory Limitations For Wood Preservatives

CRITERIA/COMMENTS	AGENCY
PCP/Drinking Water	
60 ug/L RC (MAC), 30 ug/L RC (AO) drinking	CCME-NCSRP, 1991
0.06 mg/L (MAC) (derived from an ADI of 0.006 mg/kg bw/day with an uncertainty factor of 500) <0.03 mg/L (AO) (based on threshold odour)	Guidelines for Drinking Water Quality, HWC, 1987
10 ug/L Guideline for drinking water	WHO, 1984
0.21 mg/L Guideline for drinking water	USNRC, 1977
0.22 mg/L MCLG (proposed)	USEPA, 1985
child 6 ug/L adult 7 ug/L (technical PCP) adult 9 ug/L (commercial PCP)	SNARL Guideline, USNRC, 1986
Health advisories Short term: 1 day - 1 mg/L; 10 day - 0.3 mg/L Long term: child: 0.30 mg/L; adult: 1.05 mg/L; lifetime: 0.22 mg/L	USEPA, 1987 (Office of Drinking Water)
30 ug/L	Calif. Dept. of Health Services
0.03 mg/L (AO)	MOE, 1990
0.06 mg/l (MAC)	MOE, 1990

Creosote/Drinking Water	
0.01 ug/L IAC benzo(a)pyrene 0.01 ug/L RC (MAC) benzo(a)pyrene	CCME-NCSRP, 1991
0.01 ug/L (guideline) benzo(a)pyrene*	WHO, 1983
0.01 ug/L (MAC) benzo(a)pyrene	HWC, 1988
2 ug/L (MAC) phenols	HWC, 1978
0.002 mg/L (phenols) (MDC) Maximum Desirable Concentration Related to Aesthetic Quality	MOE, 1983
Arsenic/Drinking Water	
100 ug/L RC (irrigation) 500-5000 ug/L RC (livestock) 25 ug/L RC (MAC) (drinking water)	CCME-NCSRP, 1991
0.05 mg/L (MAC) <0.005 mg/L (O) Objective	HWC, 1978
0.05 mg/L (MAC)	MOE, 1983
Chromium/Drinking Water	
100 ug/L RC (irrigation) 1000 ug/L (livestock watering) 50 ug/L RC (drinking water)	CCME-NCSRP, 1991
0.05 mg/L (MAC) <0.0002 mg/L (O)	HWC, 1986
0.05 mg/L (MAC)	MOE, 1983

Copper/Drinking Water	
200-1000 ug/L RC (irrigation) 500-5000 ug/L RC (livestock) 1000 ug/L (AO) RC (drinking water)	CCME-NCSRP, 1991
1 mg/L (MAC) <1 mg/L (O)	HWC, 1978
1 mg/L (MDC) Maximum Desirable Concentration Related to Aesthetic Quality	MOE, 1983
PCP/Groundwater	
A: <1 ug/L B: 2 ug/L C: 5 ug/L (a)	MENVIQ, 1988
A: 1 ug/L (b)	BC MOE, 1989
A: 0.01 ug/L B: 0.3 ug/L C: 1.5 ug/L (c)	Netherlands, 1990
Creosote/Groundwater	
A: 0.10 ug/L phenol 0.01 ug/L benzo(a)pyrene BD: 2 ug/L phenol 0.1 ug/L benzo(a)pyrene B(DS): 0.01 ug/L benzo(a)pyrene (b)	BC MOE, 1989 (Draft Clean-up Criteria)
A: 0.01 ug/L benzo(a)pyrene B: 0.1 ug/L benzo(a)pyrene C: 1 ug/L benzo(a)pyrene (d)	CCME, 1988 (Interim Guidelines)
A: 0.2 ug/L phenol 0.005 ug/L benzo (a) pyrene B: 15 ug/L phenol 0.2 ug/L benzo (a) pyrene C: 50 ug/L phenol 1 ug/L benzo (a) pyrene (c)	Netherlands, 1990

Creosote/Groundwater		
A: 1 ug/L phenol	(a)	MENVIQ, 1988
0.2 ug/L total PAH		
0.2 ug/L naphthalene		
0.1 ug/L phenanthrene		
0.1 ug/L fluorene/fluoranthene		
0.1 ug/L chrysene/phenanthrene/dibenzo pyrene		
0.2 ug/L anthracene		
0.5 ug/L acenaphthylene		
0.5 ug/L acenaphthene		
0.1 ug/L benzofluoranthenes/benzo pyrene	(a)	
B: 3 ug/L phenol		
10 ug/L total PAH		
10 ug/L naphthalene		
1 ug/L phenanthrene		
2 ug/L fluorene/fluoranthene		
1 ug/L chrysene/phenanthrene/dibenzo pyrene		
7 ug/L anthracene		
10 ug/L acenaphthylene		
20 ug/L acenaphthene		
0.2 ug/L benzofluoranthenes/benzo pyrene	(a)	
C: 20 ug/L phenol		
50 ug/L total PAH		
30 ug/L naphthalene		
5 ug/L phenanthrene		
10 ug/L fluorene/fluoranthene		
5 ug/L chrysene/phenanthrene/dibenzo pyrene		
20 ug/L anthracene		
20 ug/L acenaphthylene		
30 ug/L acenaphthene		
1 ug/L benzofluoranthenes/benzo pyrene	(a)	

Arsenic/Groundwater	
A: 5 ug/L BD: 50 ug/L B(DS): 50 ug/L (b)	BC MOE, 1989 (Draft Clean-up Criteria)
A: 10 ug/L B: 30 ug/L C: 100 ug/L (c)	Netherlands, 1990
Arsenic/Groundwater	
A: 5 ug/L B: 50 ug/L C: 100 ug/L (a)	MENVIQ, 1988
Chromium/Groundwater	
A: 15 ug/L BD: 50 ug/L B(DS): 50 ug/L (b)	BC MOE,1989 (Draft Clean-up Criteria)
A: 1 ug/L B: 50 ug/L C: 200 ug/L (c)	Netherlands, 1990
A: 15 ug/L B: 40 ug/L C: 500 ug/L (a)	MENVIQ, 1988

Copper/Groundwater	
A: 25 ug/L BD: 1000 ug/L B(DS): 100 ug/L (b)	BC MOE, 1989 (Draft Clean-up Criteria)
A: 15 ug/L B: 50 ug/L C: 200 ug/L (c)	Netherlands, 1990
A: 25 ug/L B: 500 ug/L C: 1000 ug/L (a)	MENVIQ, 1988
PCP/Ambient Water	
1.0 ug/L IAC, 0.5 ug/L RC (freshwater/aquatic life)	CCME-NCSRP, 1991
2 ug/L (MAC)	HWC, 1978 (to protect drinking water)
0.4 ug/L (0)	IJC, 1980 (Great Lakes Objective)
0.2 ug/L (0) (total chlorophenols) 100 ug/kg (wet wt.) (Max. in fish) 10 ug/kg (dry wt.) (Max. in bottom surface sediments)	BC MOE, 1985 (Fraser River objective)
0.5 ug/L (0) (to protect all forms of life in receiving waters)	MOE, 1987
0.05 ug/L (guideline to protect aquatic life)	CCREM, 1987
220 ug/L (MAC) (to be calculated as a function of pH and averaging time) (ingested with water/ to protect human health)	USEPA, 1986

Creosote/Ambient Water	
0.01 ug/L (O) (benzo(a)pyrene in water/to protect aquatic biota from carcinogenic and tumorigenic effects) 1.0 ug/L (O) (benzo(a)pyrene in sediments or feed for fish)	IJC, 1983
0.01 ug/L benzo(a)pyrene (guideline)	WHO, 1983
2 ug/L (MAC) (aesthetic consideration to protect drinking water)	HWC, 1978
0.05 ppm of 96 hour LC50 (for unspecified, non-persistent toxic substances)	IJC, 1977
Arsenic/Ambient Water	
0.5 mg/L (recommendation for the protection of human health)	IJC, 1977
0.05 mg/L (guideline for protection of aquatic life)	CCREM, 1987
Chromium/Ambient Water	
15 ug/L IAC, 2-20 ug/L RC (fresh-water/aquatic life)	CCME-NCSRP, 1991
0.05 mg/L (recommendation for the protection of human health)	IJC,1977
0.02 mg/L (guideline for protection of fish) 0.002 mg/L (guideline for protection of the aquatic community)	CCREM, 1987
Copper/Ambient Water	
25 ug/L IAC, 2-4 ug/L RC (freshwater/aquatic life)	CCME-NCSRP, 1991
0.005 mg/L (recommendation for the protection of aquatic life)	IJC, 1977
0.002 mg/L (hardness 0 to 120 mg/L as CaCO3) 0.003 mg/L (120 to 180 mg/L as CaCO3) 0.004 mg/L (>180 mg/L as CaCO3)	CCREM, 1987
PCP/Ambient Air	
20 ug/m3 (AAQC) 24 hour limit 60 ug/m3 (Half-hour point of impingement)	MOE, 1988

PCP/Occupational Air	
0.5 mg/m3 (TLV) (8 hour average)	ACGIH, 1986
150 mg/m3 (Im. dangerous to life or health)	NIOSH, 1978
Creosote/Ambient Air	
1 ug/m3 (AAQC) 24 hour (Coal pitch) 3 ug/m3 (Half-hour point of impingement)	MOE, 1987
Creosote/Occupational Air	
0.1 mg/m3	NIOSH, 1977
Arsenic/Ambient Air	
25 ug/m3 (AAQC) 24 hour 75 ug/m3 (1/2-hour avg point of impingement) Tentative Design Standard: 0.3 ug/m3 (AAQC) 24 hour 1 ug/m3 (1/2-hour avg point of impingement)	MOE, 1987
Arsenic/Occupational Air	
0.2 mg/m3 (TLV)	NIOSH, 1986
Chromium/Occupational Air	
0.05 mg/m3 (TLV) CrVI (water soluble)	NIOSH, 1986
Copper/Ambient Air	
50 ug/m3 (AAQC) 24 hour 100 ug/m3 (1/2-hour avg pt of impingement)	MOE, 1987

Copper/Occupational Air	
0.2 mg/m3 (TLV); 1 mg/m3 (dust)	NIOSH, 1986
PCP/Soil	
0.05 mg/kg IAC and RC (agricultural) 0.5 mg/kg RC (residential/parkland) 5 mg/kg RC (commercial/industrial)	CCME-NCSRP, 1991
A: 0.1 mg/kg (dry wt.) B: 0.5 mg/kg (dry wt.) C: 5.0 mg/kg (dry wt) (b)	BC MOE, 1989
A: <100 ug/kg B: 0.5 mg/kg C: 5 mg/kg (c)	Netherlands, 1987
A: 0.1 mg/kg B: 0.5 mg/kg C: 5 mg/kg (a)	MENVIQ, 1988
0.05 mg/kg (Tier 1 soil criteria) (e)	Alberta MOE,1990
Creosote/Soil	
0.1 mg/kg IAC and RC benzo(a)pyrene (agric) 1.0 mg/kg RC (residential/park) 10 mg/kg RC (commercial/industrial)	CCME-NCSRP, 1991
0.05 mg/kg phenol (Tier 1 draft soil criteria) (e)	Alberta Environment, 1990

A: 0.1 mg/kg phenol 0.1 mg/kg benzo(a)pyrene B: 1 mg/kg phenol 1 mg/kg benzo(a)pyrene C: 10 mg/kg phenol 10 mg/kg benzo(a)pyrene (b)	BC MOE, 1989
A: 0.1 mg/kg benzo (a) pyrene B: 1 mg/kg benzo (a) pyrene C: 10 mg/kg benzo (a) pyrene (d)	CCREM, 1988
A: 0.05 mg/kg phenol <100 ug/kg benzo (a) pyrene B: 1 mg/kg phenol 1 mg/kg benzo (a) pyrene C: 10 mg/kg phenol 10 mg/kg benzo (a) pyrene (c)	Netherlands, 1990

Creosote/Soil	
A: 0.1 mg/kg phenol (a) 1 mg/kg total PAH 0.1 mg/kg naphthalene/phenenathrene 0.1 mg/kg fluorene/fluoranthene/pyrene/acenaphthene/acenaphthylene/anthracene 0.1 mg/kg chrysene/benzo(a)pyrene/benzo-fluoranthenes/dibenzopyrenes B: 1 mg/kg phenol 20 mg/kg total PAH 5 mg/kg naphthalene/phenenathrene 10 mg/kg fluorene/fluoranthene/pyrene/acenaphthene/acenaphthylene/anthracene 1 mg/kg chrysene/benzo(a)pyrene/benzo-fluoranthenes/dibenzopyrenes C: 10 mg/kg phenol 200 mg/kg total PAH 50 mg/kg naphthalene/phenenathrene 100 mg/kg fluorene/fluoranthene/pyrene/acenaphthene/acenaphthylene/ anthracene 10 mg/kg chrysene/benzo(a)pyrene/benzo-fluoranthenes/dibenzopyrenes	MENVIQ, 1988
Arsenic/Soil	
5 mg/kg IAC, 20 mg/kg RC (agricultural) 30 mg/kg RC (residential/parkland) 50 mg/kg (commercial/industrial)	CCME-NCSRP, 1991
10 mg/kg (Tier 1 draft soil criteria) (e)	Alberta Environment, 1990
A: 29 mg/kg (dry) B: 30 mg/kg C: 50 mg/kg (c)	Netherlands, 1990

20 mg/kg (Interim Action level) (f)	NJ, 1990
Clean-up guidelines: Agricultural/Residential/Parkland 25 mg/kg (fine and medium soil) 20 mg/kg (coarse soil) Commercial/Industrial 50 mg/kg (fine and medium soil) 40 mg/kg (coarse soil)	MOE, 1989
A: 10 mg/kg B: 30 mg/kg C: 50 mg/kg	MENVIQ, 1988
10 mg/kg (threshold trigger) (g)	ICRCL, 1987
Proposed Clean-up Criteria A: 5 mg/kg B: 30 mg/kg C: 50 mg/kg (b)	BC MOE, 1989
Chromium/Soil	
TOTAL: 20 mg/kg (dry weight) IAC 750 mg/kg RC (agricultural) 250 mg/kg RC (residential/parkland) 800 mg/kg RC (commercial/industrial) Cr(VI): 2.5 mg/kg (dry weight) IAC 8 mg/kg RC (agricultural) 8 mg/kg RC (residential/parkland)	CCME-NCSRP, 1991

5 mg/kg Cr VI (Tier 1 draft soil criteria) 100 mg/kg total Cr (Tier 1 criteria) (e)	Alberta Environment, 1990
A: 20 mg/kg total B: 250 mg/kg total C: 800 mg/kg total	BC MOE, 1989
A: 100 mg/kg total B: 250 mg/kg total C: 800 mg/kg total (c)	Netherlands, 1990
100 mg/kg (Interim action level) (f)	NJ, 1990
Agricultural/Residential/Parkland 10 mg/kg CrVI; 1000 mg/kg total Cr (fine and medium soil) 8 mg/kg CrVI; 750 mg/kg total Cr (coarse) Commercial/Industrial 10 mg/kg CrVI; 1000 mg/kg total Cr (fine and medium soil) 750 mg/kg total Cr (coarse soil)	MOE, 1989
A: 75 mg/kg total B: 250 mg/kg total C: 800 mg/kg total (a)	MENVIQ, 1989
600 mg/kg total Cr (threshold trigger) 25 mg/kg CrVI (threshold trigger) (f)	ICRCL, 1987

Copper/Soil	
30 mg/kg IAC 150 mg/kg RC (agricultural) 100 mg/kg RC (residential/parkland) 500 mg/kg RC (commercial/industrial)	CCME-NCSRP, 1991
Proposed Clean-up Criteria: A: 30 mg/kg B: 100 mg/kg C: 500 mg/kg (b)	BC MOE, 1989
A: 36 mg/kg B: 100 mg/kg C: 500 mg/kg (c)	Netherlands, 1990
170 mg/kg (Interim action level (f)	NJ, 1990
Clean-up guidelines: Agricultural/Residential/Parkland 200 mg/kg (fine and medium soil) 150 mg/kg (coarse soil) Commercial/Industrial 300 mg/kg (fine and medium soil) 225 mg/kg (coarse soil)	MOE, 1989
A: 50 mg/kg B: 100 mg/kg C: 500 mg/kg (a)	MENVIQ, 1988
130 mg/kg (threshold trigger) (g)	ICRCL, 1987

(a) Indicators of environmental conditions where:

Level A represents background concentration for naturally-occurring substances and the current analytical detection limit for man-made organics.

Levels between B and A represent "slightly contaminated" soil or whereby drinking water standards or criteria are not satisfied.

Level B represents a threshold value above which a thorough site investigation is required.

Levels between C and B represent "contaminated" soils and whereby groundwater should not be used for drinking water.

Level C represents the threshold above which remedial action is necessary.

(b) Level A represents the investigation criterion based on the approx. analytical detection limit and/or natural background levels of inorganics and organics in groundwater.

Levels between A and BD or B(DS) are considered "slightly contaminated" requiring investigation.

Level BD represents the remediation criteria for drinking water.

Level B(DS) represents the de minimus criterion for discharges into water used solely for aquatic habitat. Concentrations exceeding the B(DS) requires remediation in order to protect aquatic life.

Levels ABC for soil are based on the MENVIQ-see (a) above.

(c) Level A represents the boundary between contaminated and uncontaminated (updated (1990) reference values for A have replaced the original 1983 values).

Level B represents the relative extent of contamination and the potential risk.

Level C represents concentrations above which present an intolerable risk to man or the environment based on all exposure routes.

(d) Level A represents the approx. detection limit in soil. For ground water level A is based on drinking water criteria.

Levels between A and B represent "slightly contaminated" conditions.

Level B represents a five to ten-fold factor of level A.

Levels between B and C indicate contaminated conditions. Dependant on land use, restoration may be required.

Level C represents significant contamination.

Levels above C indicate groundwater should not be used for drinking water.Restoration is required prior to use.

(e) Represent the upper limits of a "healthy soil system."

(f) Interim action levels are set based on ambient and background conditions, potential human effects and protection of groundwater quality.

(g) The threshold trigger represents a value at which concentrations, equal to or lower, present a risk no greater than is normally accepted and may be treated as uncontaminated.

Limitations on benzo(a)pyrene is considered effective in limiting other PAHs (polyaromatic hydrocarbons).

Appendix II

Acronyms

AAQC:	Ambient Air Quality Criterion
ACA:	Ammoniacal Copper Arsenate
ACGIH:	American Conference of Governmental Industrial Hygienists
ACS:	American Chemical Society
ACZA:	Ammoniacal Copper Zinc Arsenate
ADI:	Average Daily Intake
AO:	Aesthetic Objective
AWPI:	American Wood Preservers Institute
BC MOE:	British Columbia Ministry of the Environment
BTEX:	Benzene, Tolvene, Ethyl Benzene and Xylenes
CAS:	Chemial Abstract Service
CCA-C:	Chromated Copper Arsenate, Type C
CCME-NCSRP:	Canadian Council of Ministers of the Environment-National Contaminated Sites Remediation Program
CCME:	Canadian Council of Ministers of the Environment
CCREM:	Canadian Council of Resource and Environment Ministers
CFR:	Code of Federal Regulations
CITW:	Canadian Institute of Treated Wood
CPR:	Cardiovascular Pumonary Resusitation
CSA:	Canadian Standards Association
CuNap:	Copper Napthenate
CWPB:	Canadian Wood Preservatives Bureau
EPA:	Environmental Protection Agency, USA
EPRI:	Electric Power Research Institute, USA
FIFRA:	Federal Insecticide, Fangicide and Rodenticide Act, USA
HD:	Heavy Duty
HWC:	Health and Welfare Canada

IAC:	Interim Assessment Criteria (approximate background concentrations or approximate analytical detection limits
IARC:	International Agency for Research of Cancer
ICRCL:	Interdepartmental Committee on the Redevelopment of Contaminated Land (United Kingdom)
IJC:	International Joint Commission
IRG:	International Research Group (Wood Preservation)
LC 50:	Lethal Concentration, 50% Kill
LD 50:	Lethal Dose, 50% Kill
LFL:	Lower Flammability Limit
MAC:	Maximum Allowable Concentration
MCLG:	Maximum Contaminant Level Goal
MENVIQ:	Ministère de l'Environment du Québec
MOE:	Ministry of the Environment, Ontario
MSDS:	Material Safety Data Sheet
MTO:	Ministry of Transportation, Ontario
MW:	Molecular Weight
N/AV:	Not Available
NCSRP:	National Contaminated Sites Remediation Program
NIOSH:	National Institute of Occupational Safety and Health
NJ:	State of New Jersey
NSPC:	Nova Scotia Power Corporation
NTP:	National Toxicology Program
O:	Objective
OSHA:	Occupational Safety and Health Association, USA
PAH:	Polycyclic Aromatic Hydrocarbon
PCP:	Pentachlorophenol
PEG:	Polethylene Glycol

PMO:	Phenylmercuric Oleate
ppb:	parts per billion
ppm:	parts per million
PVA:	Polyvinylacetate
PVC:	Polyvinyl chloride
RC:	Remediation Criteria (considered generally protective of human and environmental health)
REPAR:	Rebuttal Presumption Against Registration
S.E.:	Standard Error
SNARL:	Suggested No-Adverse-Effect Level
STEL:	Short Term Exposure Limit
TBTO	Tri-butyl Tin Oxide
TCLP:	Toxicity Characteristic Leaching Procedure
TF:	Task Force
TLV:	Threshold Limit Value
TWA:	Time Weighted Average
U of T:	University of Toronto
UBC:	University of British Columbia
UFL:	Upper Flammibility Limit
USEPA:	United States Environmental Protection Agency
USNRC:	United States National Research Council
W/W:	Weight/Weight basis
WCI:	Wood Conversion Inc.
WHMIS:	Workplace Hazardous Material Information System
WHO:	World Health Organization

Appendix III

DOMTAR Head Office
395 de Maisonneuve Blvd. West
Montreal, Quebec
H3A 1L6

MATERIAL SAFETY DATA SHEET

EMERGENCY PHONE NUMBER
(514) 331-6100

SECTION I - PRODUCT AND PREPARATION INFORMATION

Trade Name.....: ACA

Synonym.....: AMMONIACAL COPPER ARSENATE 2% AND 8% SOLUTION

Product Code.....: N/AP

Chemical Name and Synonyms.....: CHEMONITE

CAS Number.....: N/AP

Manufacturer
Domtar - Wood Preserving

MSDS Code: CHEMWP0007E
Preparation Date: 1989/03/15

Name of Department Preparing MSDS
Wood Preserving Division
Information Tel.#....: (514) 630-2717

Name of Preparer:
Monique C. Denis

TDG Shipping Name....: ARSENICAL PESTICID LIQUID
TDG Hazard Class.....: 6.1
WHMIS Class.....: D;DIV.2 E

Hazard Rating
Health: 3 Flammability: 0
Reactivity: 0

Product Use
To preserve wood againts decay organisms d insects.

SECTION II - HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CAS NUMBER	PER CENT BY WEIGHT
		2% - 8%
ARSENIC ACID		1 - 4
COPPER OXIDE		1 - 4
AMMONIUM HYDROXIDE (29%)		1.5 - 6 (as NH_3)

SECTION III - PHYSICAL DATA

Physical state (room temperature)	LIQUID
Odour and appearance	SHARP CHARACTERISTIC ODOR, LIGHT BLUE
Odour threshold	50 PPM FOR AMMONIA
Boiling point	100%
Freezing point	-3 TO -5°C
Percent volatile by volume	1.5 - 6
Specific gravity	1.01 - 1.02
Evaporation rate	N/AV
Vapour pressure	2% - 21 mm Hg, 8% - 72 mm Hg
Vapour density	n/av
pH	2% - 10.2 , 8% - 12
Coefficient of water/oil distribution	N/AV
Solubility in water	SOLUBLE

SECTION IV - FIRE OR EXPLOSION HAZARDS

Conditions of flammability	NONE
Extinguishing media	NONE
Hazardous combustion products	NONE
Special fire fighting procedures	VAPORS NECESSITATE RESPIRATORY PROTECTION
Flash point & method of determination	WATER FOG WILL REDUCE VAPOR CON CENTRATION
Upper flammable limit	N/AP
Lower flammable limit	N/AP
Auto-ignition temperature	N/AP
Explosion data sensitivity to mechanical impact	NO
Explosion data sensitivity to static discharge	NO

SECTION V - REACTIVITY DATA

Stability	STABLE
Conditions to avoid	OPEN AIR
Incompatible substances	COPPER, TIN, ZINC, ALLOYS AND GALVANIZED SURFACES
Hazardous decomposition Products	AMMONIA GAS; UNDER HIGH TEMPE-RATURE As III
Hazardous polymerization	NO

SECTION VI - TOXICOLOGICAL PROPERTIES

Route of entry.....: Skin contact[X] Skin absorption[X] Eye contact[X]
Inhalation[X] Ingestion[X]

Effects of acute exposure.....: EYES: Irritation

SKIN: Irritation, inflammation

INGESTION: Nausea, abdominal pain, vomiting shock, coma death may occur

INHALATION: Severe irritation to nose and throat

Effects of chronic exposure.....: INGESTION: Potential carcinogenic action, possible liver and kidney damage, jaundice, reduced white blood cells upon long-term exposure.

Exposure limits

CHEMICAL COMPONENT	TWA	ACGIH TLV	LC50	LD50	IDLH
ARSENIC PENTOXIDE		.5 mg/m³	N/AV	50 mg/kg	NO
COPPER OXIDE		1 mg/m³	N/AV	400 mg/kg	NO
AQUA AMMONIA		18 mg/m³	LCLo 5000 ppm	350 mg/kg	NO

Irritancy.....: SKIN, EYES - MODERATELY IRRITATING
Sensitization.....: N/AV
Carcinogenicity.....: NO CARCINGENICITY WAS PERFORMED ON THE ACA SOLUTION BUT THE ARSENIC PENTOXIDE IS CARCINOGENIC
Reproductive toxicity.: YES
Teratogenicity.....: YES
Mutagenicity.....: N/AV
Toxicologically synergistic products.....: NO

SECTION VII - PREVENTIVE MEASURES

Hand protection.....: GLOVES: Neoprene or rubber
Eye protection.....: Gas tight chemical goggles

SECTION VII - PREVENTIVE MEASURES (CONTINUED)

Respiratory protection.....:	Canister-type respiratory approved for NH_3 are suitable when concentration are known to be < 1% by vol. Self-contained breathing apparatus must be worn when concentrations are high or unknown.
Body protection.....:	Wear apron, jackets, pants, coveralls : heavy duty lined polyvinyl chloride, vinyl coated, neoprene, rubber, NBR.
Foot protection.....:	Boots: neoprene or rubber
Ventilation controls.....:	Suffficient local exhaust ventilation to ma intain the gas levels to less than half of the TLV.

Steps to be taken in case of a leak or spill:
Stop leak if no risk involved. Stay upwind. Small spills: Take up with sand or other noncombustible absorbent material. Flush area with water. Dike large spills for later disposal. Contain runoff from fire control and dilute with water. Preferably use a liquid recovery type vacuum cleaner to recover. Use a n inert absorbent to complete a clean-up.

Waste diposal method:
Secure landfill, inquire with provincial authorities.

Precautions to be taken in handling and storing:
Do not get on skin, in eyes or on clothing. Do not wear contaminated clothing. Do not use or handle until manufacturer's safety precautions have been read and understood. Safety showers and eye wash fountains should be present.

Special shipping requirements:
None

SECTION VIII - FIRST AID MEASURES

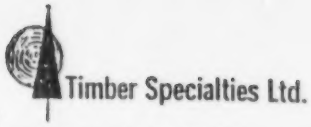
Skin contact.....:	Flush contaminated area immediately by use of flowing water. Subsequently remove soaked clothing or articles in contact with the skin. Continue to flush the contaminated skin for at least 15 minutes. Get prompt medical attention if the skin becomes inflamated (redness, itch or pain).
Eye contact.....:	Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids. Flush eyes for at least 15 minutes. Get medical attention.
Inhalation.....:	Immediately remove the exposed person to fresh air (coughing and sneezing occcurs almost immediately after excessive inhalation of ammonia fumes). Apply artificial respiration if breathing has stopped (Do not use mouth to mouth method). Keep the affected person warm and quiet. Get immmediate medical attention.

SECTION VIII - FIRST AID MEASURES (CONTINUED)

Ingestion.....: Promptly drink a large quantity of salt solution or lime water. Never give liquid to an unconscious person. Call an industrial physician or the Poison Control Center immediately for subsequent advice.* (Stomach pumping by a medical personnel is desirable)

* First aid personnel should periodically verify up-to-date response megures with the chemical suppliers and / or industrials physician.

DISCLAIMER:
Domtar believes the above Information to be reliable. Handling of this product shall be limited to qualified persons. Users must make their own tests when mixing this product with any other product or using it in any process which may alter its properties. Domtar assumes no responsibility whatsoever from any such usage.



TRADE NAME: K-33-C (50%)
GENERIC NAME: CCA Type C; Chromated Copper Arsenate

SECTION I

MSDS NUMBER: 6*T

MANUFACTURER .....:Timber Specialties, Ltd.
EMERGENCY PHONE ..:(416) 854-2244
OTHER CALLS .....:CANUTEC: (613) 996-6666 collect
ADDRESS .....:2nd Line Road West
CITY .....:Campbellville STATE ..:ON ZIP ..:L0P 1B0
MSDS PREPARED BY .:Teri Muchow
DATE PREPARED ....:June 15, 1990; Revised August 27, 1990

*** ADDITIONAL INFORMATION ***
Osmose K-33-C is designed for the pressure impregnation of wood to provide protection against decay, termites and marine borers.

For additional information on this product you may also contact:
Timber Specialties, Ltd., 980 Ellicott Street, Buffalo, NY;
Phone No. (716) 882-5905.

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

TRADE NAME .....:K-33-C (50%)
GENERIC NAME .....:CCA Type C; Chromated Copper Arsenate

INGREDIENT NAME	CAS	OSHA PEL	ACGIH TLV	RQ	%
Arsenic Acid (expressed as As2O5)	7778-39-4	0.5 mg/M3	0.2 mg/M3	5 liters	17.00
Chromic Acid (water soluble)	1333-82-0	.1 mg/M3* as Cr	.05 mg/M3 as Cr	5 liters	23.75
Copper Oxide	1317-39-1	1.0 mg/M3 as Cu	1.0 mg/M3 as Cu	5 liters	9.25

*** ADDITIONAL INFORMATION ***
* Acceptable ceiling concentration limit.
For toxicological information see Section VI.

SECTION III - CHEMICAL CHARACTERISTICS

BOILING POINT	MELTING POINT	SPECIFIC GRAVITY (WATER=1)	VAPOR PRESSURE (mm Hg)
>100 C	N/A	1.64	N/A

PERCENT VOLATILE by VOLUME	VAPOR DENSITY (air=1)	EVAPORATION RATE (Butyl Acetate)=1
50 (WATER)	N/A	N/A

SOLUBILITY IN WATER	REACTIVITY WITH WATER
100%	N/A

APPEARANCE AND ODOR :
Dark red-orange liquid. No odor.

*** ADDITIONAL INFORMATION ***
ODOR THRESHOLD: Not applicable; no odor. pH(as is): < 1.0
FREEZING POINT: -46.11 C or -51 F pH(1% Soln.): 1.8 - 2.0
COEFFICIENT OF WATER/
OIL DISTRIBUTION: Not applicable

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	METHOD	FLAMMABLE LIMITS IN AIR (%)	AUTOIGNITION TEMPERATURE
N/A	N/A	UPPER = N/A LOWER = N/A	N/A

EXTINGUISHER MEDIA: Water Fog and/or Carbon Dioxide

SPECIAL FIRE FIGHTING PROCEDURES:
This product will not burn; 50% aqueous solution. When heated to decomposition, arsenic may be emitted. If this material is involved in a fire or explosion, carbon dioxide or water may be used as an extinguishing agent. Wear complete fire service protection equipment, including full-face MSHA/NIOSH approved self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Chromic acid content of this product is a strong oxidizing agent; contact with strong reducing agents may cause an explosion. May cause fire on contact with combustible materials. Closed containers may explode when exposed to extreme heat (fire).

*** ADDITIONAL INFORMATION ***

HAZARDOUS COMBUSTION PRODUCTS: When heated to decomposition, arsenic may be emitted.

EXPLOSION DATA:

1) Sensitivity of impact: Not applicable.
2) Sensitivity to static discharge: Not applicable.

SECTION V - REACTIVITY DATA

IS THIS CHEMICAL STABLE UNDER NORMAL CONDITIONS OF HANDLING/STORAGE (Y/N)? Y

CONDITIONS TO AVOID:
Reducing Agents

INCOMPATIBILITY (MATERIALS TO AVOID):
Strong reducing agents. Aluminum and zinc in an acid medium.

HAZARDOUS DECOMPOSITION PRODUCTS:
Under certain conditions where aluminum and zinc (e.g. galvanized steel) are present, arsine gas may be generated.

HAZARDOUS POLYMERIZATION POSSIBLE (Y/N) ? N

CONDITIONS TO AVOID:
N/A

SECTION VI - HEALTH HAZARDS

ROUTES OF ENTRY: The principal routes of exposure for this solution are by skin or eye contact. If the pesticide application process generates mist or particles, inhalation is an additional significant route of exposure. This solution is highly corrosive, as indicated by its pH. Skin or eye contact may result in severe burns. Chronic skin exposure may result in skin ulcers. Inhalation of this solution is highly irritating, and acute exposure by inhalation may result in chemical pneumonitis.

SIGNS AND SYMPTOMS OF -
ACUTE OVEREXPOSURE:
Highly irritating to skin and eyes. Repeated dermal exposure may cause dermatitis. Toxic by ingestion, causes gastroenteritis, esophageal pain, vomiting and anuria or oliguria.

CHRONIC OVEREXPOSURE:
Repeated dermal exposure may cause dermatitis. See Chronic Effects Notes, page 4.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:
Individuals with an existing (or a history of) disease of the skin, kidney, liver, lungs or nervous system may be at greater risk of developing either acute or chronic health effects.

CHEMICAL LISTED AS A CARCINOGEN OR POTENTIAL CARCINOGEN

NATIONAL TOXICOLOGY PROGRAM (Y/N): N	IARC MONOGRAPHS (Y/N): N	OSHA (Y/N): N

*** ADDITIONAL INFORMATION ***

For CARCINOGEN information, see Chronic Effects Notes, page 4.

Toxicological Information: LD50 - > 50 mg/kg
Dermal LD50 - < 200 mg/kg

EXPOSURE LIMITS: See Section II

IRRITANCY OF PRODUCT: See Section VI

SENSITIZATION TO PRODUCT: Not Determined

TERATOGENICITY: Not Determined

REPRODUCTIVE TOXICITY: Not Determined

MUTAGENICITY: Not Determined

SYNERGISTIC PRODUCTS: Not Determined

EMERGENCY AND FIRST AID PROCEDURES

EMERGENCY PHONE NUMBER OF MANUFACTURER: (416) 854-2244

1. INHALATION: For acute inhalation, remove the victim from exposure, restore breathing and seek medical attention immediately.

2. EYE CONTACT: Immediately flush with large quantities of water. Seek medical attention as soon as possible.

3. SKIN CONTACT: Immediately flush skin with large volumes of water. Seek medical attention as soon as possible.

4. INGESTION: Immediately seek medical attention; do not induce vomiting. If it appears that the victim may not receive medical attention within 15 minutes, and if conscious, give one glass of milk, preferably containing 2 ounces of milk of magnesia or 3 egg whites, or give lime water or 1 tablespoon salt in warm water; induct vomiting.

*** ADDITIONAL INFORMATION ***

NOTES TO PHYSICIAN: Treat for arsenic pentoxide (As_2O_5) and chromium trioxide (CrO_3) exposure. Severe arsenic poisoning from occupational exposure is unlikely. If it should occur, administer BAL (dimercaprol) 10% in oil, IM, 3 mg/kg for each injection: day 1 and 2, every four hours; day 3, every 6 hours; day 4 - 14, every 12 hours. Consider gastric lavage (if vomiting has not already occurred).

CHRONIC EFFECTS

IARC, NTP and OSHA do not consistently distinguish among arsenic or chromium compounds, but list inorganic arsenic and chromium and certain specific chromium compounds as human carcinogens. Such listings have been based upon cancer in human populations following long term consumption of inorganic trivalent arsenic, inhalation and skin contact with inorganic trivalent arsenical compounds and the combined inhalation of arsenic trioxide, sulfur dioxide and other particulates from ore smelting in arsenic trioxide protection. The ACGIH has not listed inorganic arsenic as a carcinogen, but has listed the production of arsenic trioxide as a process which may lead to the development of cancer. In addition, cancers in humans have followed long term occupational exposure to certain nonwater soluble hexavalent chromium.

This product does not contain trivalent arsenic or nonwater-soluble hexavalent chromium compounds. Furthermore, epidemiology studies and cross sectional health studies of treating plant workers would indicate that this product is not a carcinogen when used in accordance with customary practices found in the wood preserving industry.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:
Engineering controls are the preferred method for controling exposure to chemicals. If enginering controls are not feasible, then personal protective equipment should be utilized. Read Osmose Operation Manual. For Pesticide Applicators, read and understand the label thoroughly. Note, the EPA PEL program is part of the label.

OTHER PRECAUTIONS:
Launder contaminated clothing before reuse. If interior of shoes are contaminated, either directly or through penetration, delayed skin burns may occur, therefore discard. READ PRODUCT LABEL.

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:
Avoid contact with solution. Prevent spread of the spill or leak. Recover or neutralize free standing liquid with Osmose Neutralizing Compound or sawdust. Collect absorbent and contaminated soil in DOT approved containers. This material is toxic to fish and other wildlife, do not allow it to contaminate waterways. Individuals involved in clean-up should be protected from contact with the solution by using appropriate protective equipment. The RQ for this material is five (5) liters. If more than 5 liters is released an dit represents a danger to health, life, property or the environment, contact the local police and file a Dangerous Occurrence report.

WASTE DISPOSAL METHODS:
Dispose in accordance with all Federal/Provincial laws. Excess chemical and waste material collected from a release or spill must be disposed of in an approved hazardous waste disposal site in accordance with Federal guidelines. Containers may be triple rinsed and then buried in a sanitary landfill or removed to a drum reclaimer.

*** ADDITIONAL INFORMATION ***

HANDLING PROCEDURES AND EQUIPMENT: See Section VIII

STORAGE REQUIREMENTS: Do not contaminate water, food or feed by storage or disposal.

SPECIAL SHIPPING INFORMATION: Poisonous Liquids, N.O.S., UN2810 Class 6.1

SECTION VIII - CONTROL MEASURES

RESPIRATORY PROTECTION:
When respiratory exposure can exceed 0.01 mg/m3, states that a half-mask air purifying respirator equipped with high effeciency particulate filters is recommended. When environmental airborne concentrations are greater than this level, refer to EPA PEL program and the plant operating manual.

VENTILATION REQUIREMENTS:
N/A

LOCAL EXHAUST:
Sufficient

MECHANICAL:
N/A

SPECIAL:
N/A

OTHER:
N/A

PROTECTIVE GLOVES:
Workers must wear gloves (NBR, natural rubber, neoprene, coated vinyl or PVC).

EYE PROTECTION:
Chemical goggles and face shield.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT:
An apron and other equipment necessary to avoid dermal contact.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: - Continued

WORK/HYGENIC PRACTICES:
Wash thoroughly after skin contact, and before eating, drinking, use of tobacco products, or using restrooms.

*** ADDITIONAL INFORMATION ***

FOOTWEAR: As necessary to avoid dermal contact.

CLOTHING: See product label. Protective clothing must be changed when it shows signs of contamination.

ENGINEERING CONTROLS: See Plant Operating Manual

N/A = Not Applicable N/D = Not Determined

NOTICE: The information herein is given in good faith but no warranty, expressed or implied is made, and Timber Specialties, Ltd. expressly disclaims liability from reliance on such information.

Information on this form is furnished for the purpose of compliance with the Workplace Hazardous Materials Information System and shall not be used for any other purpose. Use or dissemination of all or part of this information for any other purpose may result in a violation of law or constitute grounds for legal action.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: - Continued

WORK/HYGENIC PRACTICES:
Wash thoroughly after skin contact, and before eating, drinking, use of tobacco products, or using restrooms.

*** ADDITIONAL INFORMATION ***

FOOTWEAR: As necessary to avoid dermal contact.

CLOTHING: See product label. Protective clothing must be changed when it shows signs of contamination.

ENGINEERING CONTROLS: See Plant Operating Manual

N/A = Not Applicable N/D = Not Determined

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MATERIAL SAFETY DATA SHEET
Meeting OSHA Standard 29 CFR 1910.1200 (g)
MOONEY CHEMICALS, INC.
2301 Scranton Road
Cleveland, Ohio 44113
Effective Date: 03/15/91: Supersedes:09/25/85

SECTION I: IDENTIFICATION AND EMERGENCY INFORMATION

TRADE NAME: M-GARD S520
PRODUCT CODE: 705
PRODUCT DESCRIPTION: Green Liquid
EPA REGISTRATION NO. 9630-12
AFTER HOURS TELEPHONE NO. 814-432-2125
BUSINESS HOURS TELEPHONE NO. 216-781-8383

SECTION II: COMPONENTS AND HAZARD INFORMATION

COMPONENT	CAS NO.	% WT.	EXPOSURE GUIDELINES				
			OSHA		ACGIH		UNITS
			PEL TWA	STEL	TLV TWA	STEL	
Cu Naphthenate	1338-02-9	74	1				mg/m^3
Mineral Spirits	8052-41-3	26	100 ppm		525		mg/m^3

OSHA 29 CFR 1910.1000 Table Z-1-A (Final Rule) list for Copper dusts and mists (as Cu)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)

Health	Flammability	Reactivity	Protective Equipment
2	2	0	B

SECTION III: PRIMARY ROUTES OF ENTRY AND EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: May cause eye irritation. Flush with large amounts of water, lifting upper and lower lids occasionally. Get medical attention.

SKIN: May cause skin irritation. Thoroughly wash exposed area with soap and water. Remove contaminated clothing. Launder contaminated clothing before re-use.

INHALATION: May be harmful if inhaled. May cause respiratory irritation. If affected, remove individual to fresh air. If breathing is difficult, administer oxygen. If breathing is stopped, give artificial respiration. Keep person warm, quiet. Get medical attention.

INGESTION: May be harmful if swallowed. Do not induce vomiting. Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal.

SECTION IV: FIRE AND EXPLOSION HAZARD INFORMATION

Flash Point (Minimum)°F: 150

Handling Precautions
Use product with caution around heat, sparks, pilot lights, static electricity, and open flame.

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES
Foam, water spray (fog) dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product, depending on size or potential size of fire and circumstances related to the situation. Plan fire protection and response strategy through consultation with local fire protection authorities or appropriate specialists.

If a leak or spill has not ignited, use water spray to disperse the vapors and to provide protection for men attempting to stop a leak. Water spray spray may be used to flush spills away from exposures. Minimize breathing gases, vapor, fumes or decomposition products. Use self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode as needed.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS
Carbon monoxide, carbon dioxide, various hydrocarbons.

"EMPTY" CONTAINER WARNING:
"Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD,BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION: THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION V: HEALTH AND HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE (Signs and Symptoms of Exposure)
May cause eye, skin or respiratory irritation. May be harmful if inhaled or swallowed. May cause central nervous system depression. May cause headache and dizziness.

NATURE OF HAZARD AND TOXICITY INFORMATION

Carcinogenicity: NTP: __ Yes XX No
IARC: __ Yes XX No
OSHA: __ Yes XX No

SECTION VI: PHYSICAL DATA

The following data are approximate or typical values and should not be used for precise design purposes.

Boiling Range: 315-385°F

Vapor Density (Air = 1)
Heavier than air

Evaporation Rate
Slower than ether

Odor: Characteristic Mineral Spirits

Vapor Pressure: 2.6 mm Hg/20°C (for mineral spirits)

% Volatile by Weight: 26

% Volatile by Volume: 33

Weight per Gal., Lbs. 8.2

Color: Green

SECTION VII: REACTIVITY

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidizing agents (e.g., nitric acid, permanganates).

SECTION VIII: ENVIRONMENTAL INFORMATION

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Eliminate all sources of ignition (flares, flames, including pilot lights, electrical sparks). Persons not wearing protective equipment should be excluded from area of spill until clean-up has been completed. Stop spill at source. Dike area of spill to prevent spreading, pump liquid to salvage tank. Remaining liquid may be taken up on sand, clay, earth, or floor absorbent and shoveled into containers. Prevent run-off to sewers, streams or other bodies of water.

SECTION IX: PROTECTION AND PRECAUTIONS

VENTILATION: Provide sufficient mechanical (general) and/or local exhaust ventilation to maintain exposure below TLVs.

RESPIRATORY PROTECTION: A NIOSH/MSHA jointly approved self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive mode is advised: however, OSHA regulations also permit other NIOSH/MSHA respirators under specified conditions.

PROTECTIVE GLOVES: Wear resistant gloves such as Neoprene.

EYE PROTECTION: Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses.

OTHER PROTECTIVE EQUIPMENT: Use chemical-resistant apron or other impervious clothing, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact.

WORK PRACTICES/ENGINEERING CONTROLS

Keep containers and storage containers closed when not in use. Do not store near heat, sparks, flame or open flames.

PERSONAL HYGIENE: Minimize breathing vapor, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing; launder or dry clean before reuse. Remove contaminated shoes and thoroughly clean before reuse. Wash thoroughly after contact, before breaks and meals, and at the end of the day.

SECTION X: TRANSPORTATION INFORMATION

TRANSPORTATION INCIDENT INFORMATION
For further information relative to spills resulting from transportation incidents, refer to the latest Department of Transportation Emergency Response Guidebook, DOT P 5800.5. Guide 26

DOT IDENTIFICATION NUMBER

Classifications: DOT Shipping Name: Combustible Liquid, N.O.S.
DOT Hazard Class: Combustible Liquid
UN or NA Number: NA 1993

Material with a flash point of 100°F - 200°F are subject to the Hazardous Material Regulations only in 110 gallon containers or larger - 49 CFR 173.118 (a).

INTERNATIONAL TRANSPORTATION:

Hazardous Material: _____Yes __XX__No
For further information, refer to the latest IMCO Regulations.

AIR FREIGHT TRANSPORTATION:

Hazardous Material: _____Yes __XX__No
For further information, refer to the latest ICAO Regulations or IATA Regulations.

SECTION XI: SPECIAL COMMENTS

TSCA: All components are listed on TSCA Inventory: XX Yes ___No

SARA:

Section 302 Extremely Hazardous Substance List 40 CFR 355 ___Yes XX No
Section 313 Toxic Chemical List 40 CFR 372.65 XX Yes ___No

CAS No.	Chemical Name	% by Weight
Not Applicable	Copper Compounds	74

CERCLA: Hazardous Substance List 40 CFR 302.4 ___Yes XX No
RQ Lbs.: _____

The information and recommendations contained herein are, to the best of Mooney's knowledge and belief, accurate and reliable as of the date issued. Mooney does not warrant or guarantee their accuracy or reliability, and Mooney ASSUMES NO LIABILITY. No warranties of merchantability, fitness or otherwise are created. MOONEY SHALL NOT BE LIABLE FOR SPECIAL INCIDENTAL AND CONSEQUENTIAL DAMAGES.

CARBOCHEM INC.
725 Strathearne Avenue North
Hamilton, Ontario
L8H 5L3

CARBOCHEM Inc.
a Rütgerswerke AG Company

EMERGENCY TELEPHONE NO:
(416) 544-3722

MATERIAL SAFETY DATA SHEET

FOR TRANSPORTATION EMERGENCIES CALL COLLECT
CANUTEC (613) 996-6666

I) PRODUCT IDENTIFIER : CREOSOTE

II) PREPARED BY : TECHNICAL MANAGER PHONE : (416) 544-2891
EFFECTIVE DATE : JUNE 1990

Product Name(s) :
CREOSOTE , COAL TAR

Formula :COMPLEX MIXTURE OF AROMATIC END HETEROCYCLIC HYDROCARBONS

Synonym(s):
Brick oil, Creosote oil, # P-1
P-7, Dead oil
Brushing Grade Creosote

Chemical Family :
POLYAROMATIC HYDROCARBONS

W.H.M.I.S. Classification
Class(es) : B.3 and D.2A

Product Use(s) :
Wood Preservative
Lubricant (Die moulding)

Hazard Classification
Flammability : 1
Health : 3
Reactivity : 0

T.D.G Shipping name :
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (CREOSOTE)

T.D.G. Classification:
Class(es) : 9.2

SHIPPING TO U.S.A. ONLY
D.O.T. Shipping Name :

R.Q. COMBUSTIBLE LIQUID N.O.S.
(CONTAINS CREOSOTE)

D.O.T. Hazard Classification :

COMBUSTIBLE LIQUID

P.I.N./U.N. Number : NA 1993

(III) PHYSICAL DATA

Odour and appearance: BROWN TO BLACK LIQUID WITH AROMATIC ODOUR

Physical State : LIQUID @ 15.5°C
Specific Gravity: 1.06 -1.1
Boiling Point: >150°C
Vapour Pressure : N.A.
pH : N.A.
Coefficient of Water/oil Distribution : N.A.

Solubility in Water : NEGLIGIBLE
% Volatiles: 100% ABOVE 360°C
Vapour density: N.A N.A.
Freezing Point: <5°C
Evaporation rate :
Odour Threshold: N.A.

HAZARDOUS INGREDIENTS

	INGREDIENTS	C.A.S. or U.N. NUMBER(S)	CONC. % W./W.	L.D. 50 Species & Route	L.D. 50 Species & Route
1	CREOSOTE, Coal Tar	CAS 8001-58-9	100	Or-rat 725 mg/Kg	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

FIRE OR EXPLOSION HAZARDS

Flash Point : 92°c (PMCC) | U.F.L. : N.A. | L.F.L.: N.A. | Autoignition Temp.: N.A.
Sensitivity to mechanical Impact : NONE | Sensitivity to static discharge : NONE
Conditions of flammability : Vapours may ignite if the product is heated above the Flash Point
NAPHTHALENE COMPONENT IN CREOSOTE MAY SUBLIMATE WHEN HEATED. VAPOUR OR DUST MAY CREATE EXPLOSIVE HAZARDS.
Means of extinction : Sand, CO2, Foam, Water Fog, Dry Chemical.

Special Procedures: WEAR S.C.B.A., FULL PROTECTIVE CLOTHING, CONTAIN RUN-OFF WATER.

Hazardous Combustion Products : CO2, CO, NOx, SO2.

REACTIVITY DATA

Chemical Stability : Yes X No
Hazardous Polymerization : WILL NOT OCCUR
Incompatibility : OXIDIZING AGENTS
Reactivity (and conditions): MINIMAL REACTIVITY @ AMBIENT TEMPERATURES
Hazardous decomposition products: CO2, CO, P.A.H.'s.

Conditions of Instability: NONE KNOWN @ S.T.P.
Corrositivity : NON CORROSIVE

TOXICOLOGICAL PROPERTIES | Route of Entry: Skin __X__ Eye __X__ Ingestion __X__ Inhalation __X__

Teratogen : DATA NOT AVAILABLE

Carcinogen : CLASSIFIED AS POSSIBLE HUMAN CARCINOGEN BY I.A.R.C.

Effects of ACUTE exposure : IRRITATING TO SKIN, EYES, THROAT AND NOSE. SEVERE BURN AND INFLAMATION MAY RESULT AFTER CONTACT WITH LIQUID .

EYE : INFLAMMATION, CONJUNCTIVITIS, SCARRING OF CORNEA.

SKIN : BLISTERING, PHOTOSENSITATION, BURNS, TISSUE NECROSIS.

INGESTION : SALIVATION, VOMITING, DIZZINESS, IRREGULAR PULSE, HYPOTERMIA, RENAL FAILURE, MILD CONVULSIONS, CYANOSIS.

Effects of CHRONIC exposure :

SKIN : IRRITATION, BLISTERING, ULCERATIONS, PIGMENTATION, FORMATION OF WARTS OR HARDENING OF THE SKIN.
STUDIES ON ANIMALS AND HUMAN (INCOMPLETE) EPIDEMIOLOGICAL STUDIES INDICATE CREOSOTES AS POSSIBLE HUMAN CARCINOGEN.

T.L.V. -T.W.A. : 0.2 mg/M3

Sensitization: SEE EXPOSURE Synergistic effects: N.A. Irritancy : SEE EXPOSURE

FIRST AID | Eye : FLUSH IMMEDIATELY WITH LUKEWARM WATER FOR AT LEAST 30 MINUTES, HOLDING THE EYELIDS OPEN. OBTAIN MEDICAL ATTENTION IMMEDIATELY.

Ingestion : DO NOT INDUCE VOMITING. IF THE VICTIM IS CONSCIOUS, RINSE THE MOUTH WITH WATER. HAVE THE VICTIM DRINK 8 TO 10 oz. OF WATER (IF CONSCIOUS),TO DILUTE THE STOMACH CONTENT. SHOULD VOMIT OCCUR, LEAN THE VICTIM FORWARD TO REDUCE RISK OF SUFFOCATION. OBTAIN MEDICAL ATTENTION IMMEDIATELY.

Inhalation : MOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, BEGIN C.P.R. IMMEDIATELY. OBTAIN MEDICAL ATTENTION IMMEDIATELY.

SKIN : REMOVE CONTAMINATED CLOTHES, BLOT EXCESS AWAY, WASH WITH WATER AND A NON ABRASIVE SOAP. RINSE FOR AT LEAST 20 MINUTES WITH LUKEWARM WATER.
OBTAIN MEDICAL ATTENTION IMMEDIATELY.

PREVENTIVE MEASURES | Personal Protection : Eye- CHEMICAL GOGGLES Hand- IMPERVIOUS (RUBBER) GLOVES
Feet- IMPERVIOUS (RUBBER) SHOES Clothing - IMPERVIOUS (RUBBER) APRON

Respirator : ORGANIC VAPOURS IF SMALL QUANTITIES ARE SUSPECTED. S.C.B.A. IN CASE OF MAJOR LEAKS.

Engineering Controls : NATURAL VENTILATION. MECHANICAL VENTILATION IN ENCLOSED AREAS.

Spill & Leak procedure: TRY TO STOP THE SOURCE OF THE LEAK IF POSSIBLE WITHOUT HAZARD.
CONTAIN PRODUCT WITH DIKES (IF QUANTITIES REQUIRE IT), KEEP MATERIAL AWAY FROM SEWERS, WATER SOURCES.
ABSORB WITH ACTIVATED CHARCOAL, SAND, CLAY, SAWDUST OR WOODCHIPS (WITH THE LATTER TWO, BEWARE OF FIRE HAZARDS).
NOTIFY AUTHORITIES IN CASE OF RELEASE IN THE ENVIRONMENT.

Waste disposal : FEDERAL, PROVINCIAL AND LOCAL REGULATIONS ARE TO BE CONSULTED PRIOR TO DISPOSAL.
CONTAMINATED ABSORBENTS MAY BE BURNED IN APPROVED INCINERATORS.

Storage requirements : STORE AWAY FROM SOURCES OF HEAT, FLAMES.

Special Shipping Informations : THIS PRODUCT MAY BE SHIPPED AND STORED AT TEMPERATURES ABOVE 60°C. DO NOT TOUCH UNINSULATED VESSELS OR PIPES WITHOUT GLOVES.

Vulcan CHEMICALS

MATERIAL SAFETY DATA SHEET

24 Hour Emergency Phone (316) 524-5751

Division of Vulcan Materials Company / P.O. Box 530390 • Birmingham, AL 35253-0390

I - IDENTIFICATION

CHEMICAL NAME	CHEMICAL FORMULA	MOLECULAR WEIGHT
Pentachlorophenol	C_6Cl_5OH	266.32

TRADE NAME
GLAZD® Penta, Block Penta

SYNONYMS
Penta, PCP, Technical Grade PCP, Chloropnenols, Solid

DOT IDENTIFICATION NO.
UN 2020

II- PRODUCT AND COMPONENT DATA

COMPONENT(S) CHEMICAL NAME	CAS REGISTRY NO.	% (wt.) Approx	OSHA PEL
* Pentachlorophenol	87-86-5	90-9⅘	0.5 mg/m³
2, 3, 4, 6-Tetrachlorophenol	58-90-2	0-1.5	None
Hydroxypolychlorodibenzo Ethers		4-7	None
For additional information refer to note in Section VI, Chronic Toxicity.			
NOTE: The hazards of this product are based on studies on this or similar products.			

* Denotes chemical subject to reporting requirements of Section 313 of Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) and 40 CFR Part 372

III - PHYSICAL DATA

APPEARANCE AND ODOR	SPECIFIC GRAVITY
Light brown or tan flake or solid	Flake bulk density - 70 lbs/ft³
BOILING POINT	**VAPOR DENSITY IN AIR (Air = 1)**
310°C (Melting Point: 190°C)	N/A
VAPOR PRESSURE	**% VOLATILE, BY VOLUME**
N/A	0
EVAPORATION RATE	**SOLUBILITY IN WATER**
N/A	14 ppm @ 20°C

IV - REACTIVITY DATA

STABILITY	CONDITIONS TO AVOID
Stable	Avoid contact with open flame, electric arcs, or other hot surfaces which can cause thermal decomposition.

INCOMPATIBILITY (Materials to avoid)

Strong oxidizers and alkalies.

HAZARDOUS DECOMPOSITION PRODUCTS

Hydrogen chloride, chlorine, chlorinated hydrocarbons

HAZARDOUS POLYMERIZATION

Will not occur

V – FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT (Method used)	FLAMMABLE LIMITS IN AIR
None	None

EXTINGUISHING AGENTS

None NFPA Hazard Ratings: Health 3, Flammability 0, Reactivity 0

UNUSUAL FIRE AND EXPLOSION HAZARDS

Toxic gases are formed by thermal decomposition. Firefighters should wear self contained positive pressure breathing apparatus, and avoid skin contact.

VI – TOXICITY AND FIRST AID

EXPOSURE LIMITS (When exposure to this product and other chemicals is concurrent, the exposure limit must be defined in the workplace)

	ACGIH Biological Exposure Indices
ACGIH: 0.5 mg/m³ 8 hour TWA	(2 mg/L urine)
OSHA: 0.5 mg/m³ 8 hour TWA	(5 mg/L plasma)
(skin absorption possible)	

Effects described in this section are believed not to occur if exposures are maintained at or below appropriate TLVs.
Because of the wide variation in individual susceptibility, these exposure limits may not be applicable to all persons and those with medical conditions listed below.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Acute or chronic kidney or liver disease, asthma, bronchitis, chronic acne and other skin conditions.

ACUTE TOXICITY Primary route(s) of exposure: ☒ Inhalation ☒ Skin Absorption ☐ Ingestion

Inhalation: Concentrations of 0.3 mg/m³ can cause nose irritation. Concentrations above 1 mg/m³ can cause irritation of upper respiratory tract with sneezing and coughing. Persons acclimated to pentachlorophenol can tolerate levels above 2 mg/m³. Symptoms of overexposure include rapid heartbeat and respiration, elevated temperature and blood pressure, muscular weakness, excessive sweating, dizziness and nausea. High concentrations can cause unconciousness, convulsions and death generally from cardiac arrest.

Skin: Pentachlorophenol is readily absorbed through intact skin. Pentachlorophenol in solution can be readily absorbed through intact skin in toxic amounts, causing systemic poisoning and symptoms described in the Inhalation section. Pentachlorophenol on the skin can cause irritation.

Eyes: Pentachlorophenol causes irritation of the eyes at 1 mg/m³. If exposure is prolonged, slight transient corneal damge can occur.

Ingestion: Single dose toxicity is high. Symptoms of ingestion are those described in the Inhalation section.

Chloracne: In humans, the absorption of pentachlorophenol by any route may result in the development of the skin condition, chloracne. This usually appears as blackheads, whiteheads and yellow cysts over the temples and around the ears. In severe cases, involvement may be extensive. Mild cases may be similar in appearance to other forms of acne and to skin changes commonly seen with aging.

FIRST AID

Inhalation: Move victim to fresh air. If breathing has stopped, administer artificial respiration. Call a physician.
Skin: Remove contaminated clothing and shoes. Wash skin thoroughly with soap and water for at least 15 minutes. Wash contaminated clothing before reuse.
Eyes: Flush eyes immediately with water for at least 15 minutes. Contact a physician.
Ingestion: Call a physician or Poison Control Center immediately. If possible, vomiting should be induced under medical supervision. Drink one or two glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.
NOTE TO PHYSICIAN: This product is a metabolic stimulant. Treatment is supportive. Forced diuresis may be effective to reduce total body burden. Treat hyperthermia with physical measures. Do not administer aspirin, phenothiazines, or atropine since they may enhance toxicity.

CHRONIC TOXICITY

The finding of chronic toxic effects in laboratory animals may indicate toxicity to humans. Overexposure should be avoided, failure to do so could result in injury, illness or even death. Chronic overexposure to technical grade pentachlorophenol has caused liver and kidney toxic effects in experimental animals.

Carcinogenicity: Technical Grade Pentachlorophenol has been evaluated for possible cancer causing effects in laboratory animals. The National Toxicology Program fed up to 400 ppm Technical Grade (TG) penta and up to 600 ppm "purified" penta to mice, 5 days a week for 106 weeks. A statistically significant increased incidence of liver tumors and endocrine tumors was observed in male mice. A significant increase in liver tumors was not seen in female mice fed TG penta and was seen only at the highest dose for "purified" penta. Vascular tumors were also observed in female mice. Rats exposed by ingestion to concentrations up to 30 mg/kg/day for 2 years and two strains of mice exposed by ingestion to concentrations up to 46.4 mg/kg/day did not show an increase incidence in tumors. Two strains of mice were also tested by having Technical Grade Pentachlorophenol subcutaneously injected. These mice did not show an increased incidence of tumors. Pentachlorophenol, 2,3,4,6-tetrachlorophenol and hydroxypolychlorodibenzo ethers are not listed on the IARC, NTP or OSHA carcinogen lists.

Reproductive Toxicity: Reproductive toxicity tests have been conducted to evaluate the potential adverse effects technical grade and purified pentachlorophenol may have on reproduction and offspring of laboratory animals. Both technical and purified pentachlorophenol have been found to be embryo and fetotoxic to rats, but not to hamsters. Neither technical grade nor purified pentachlorophenol caused teratogenic effects (birth defects), but did cause delays in normal fetal development. The U.S. EPA has expressed the opinion that pentachlorophenol can produce defects in the offspring of laboratory animals. Exposure to pentachlorophenol during pregnancy should be avoided.

Note: This product contains trace quantities of hexa, hepta and octachlorodibenzo-p-dioxins, hexa, hepta and octchlorodibenzofurans and hexachlorobenzene. The state of California has listed hexachlorodibenzo dioxin and hexachlorobenzene under Proposition 65 as chemicals known to the state to cause cancer. If further information is desired, contact Vulcan Chemicals Technical Service Department.

VII - PERSONAL PROTECTION AND CONTROLS

RESPIRATORY PROTECTION

Where concentrations of pentachlorophenol exceed or are likely to exceed .5 mg/m^3, a NIOSH/MSHA approved organic vapor-dust filter type respirator is acceptable. A NIOSH/MSHA approved self-contained breathing apparatus or air line respirator, with full face piece, is required for concentrations above 150.0 mg/m^3, or during emergency and spills. Follow applicable respirator use standards and regulations.

VENTILATION

Do not use in closed or confined space. Open doors and/or windows. Use ventilation to maintain exposure levels below 0.5 mg/m^3

SKIN PROTECTION Wear PVC, neoprene, nitrile latex or equivalent gloves and tightly woven clothing including long sleeve shirt when handling flake or solid penta. When mixing penta solutions, wear protective clothing, gloves and boots or shoes, which are suitable for the solvent being used.

EYE PROTECTION

Wear safety glasses. Contact lenses should not be worn. When mixing penta solutions, wear chemical goggles and/or face shield.

HYGIENE

Avoid contact with skin and breathing dust. Do not eat, drink, or smoke in work area. Wash hands prior to eating, drinking or using restroom. Change into uncontaminated clothing before leaving work premises. (Refer to Section VIII).

OTHER CONTROL MEASURES

To determine the exposure level(s), monitoring should be performed regularly. Safety shower and eye wash station should be available. Note: Protective equipment and clothing should be selected, used, and maintained according to applicable standards and regulations. For further information, contact the clothing or equipment manufacturer or the Vulcan Chemicals Technical Service Department.

VIII - STORAGE AND HANDLING PRECAUTIONS

Follow protective controls set forth in Section VII when handling this product.
Store in properly labeled containers in dry, well ventilated secure area.
Thoroughly wash potentially contaminated clothing before reuse. Do not launder work clothes with other non-contaminated clothes and/or household laundry.
Contaminated clothing, boots or equipment should not be taken home.
Do not remove or deface label. Do not reuse drums for any purpose.
Container Disposal: Completely empty drum or liner into application equipment. Triple rinse or clean empty drums, liners and block wrappings in accordance with 40 CFR 261.7(b)(3) prior to offering for reconditioning, recycling or other disposal. For guidance, contact the nearest EPA regional office or State Agency authorized to administer the Resource Conservation and Recovery Act (RCRA).
SARA Title III Hazard Categories: Immediate Health, Delayed Health

IX - SPILL, LEAK AND DISPOSAL PRACTICES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Ventilate spill area and avoid breathing dust or vapors. Clean up spilled material (wear protective equipment - See Section VII) and place in closed container for normal use if possible or proper disposal. Penta is toxic to fish and wildlife; do not allow to contaminate ground or surface waters. Reportable Quantity (RQ) is 10 lbs. Notify National Response Center (800/424-8802) of uncontrolled spills in excess of RQ.

WASTE DISPOSAL METHOD

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA regional office for guidance.

X - TRANSPORTATION

DOT HAZARD CLASSIFICATION

Chlorophenols, Solid, 6.1, Un 2020, PG III, RQ (Pentachlorophenol)

PLACARD REQUIRED

KEEP AWAY FROM FOOD, 2020, Class 6

LABEL REQUIRED

KEEP AWAY FROM FOOD, Class 6
Label as required by EPA and by OSHA Hazard Communication Standard, and any applicable state and local regulations.

Medical Emergencies

Call collect 24 hours a day for emergency toxicological information 415/821-5338

Other Emergency information

Call 316/524-5751 (24 hours)

For any other information contact:

Vulcan Chemicals
Technical Service Department
P.O. Box 530390
Birmingham, AL 35253-0390
800/873-4898
8 AM to 5 PM Central Time
Monday Through Friday

DATE OF PREPARATION: October 1, 1991

NOTICE: Vulcan Chemicals believes that the information contained on this Material Safety Data Sheet is accurate. The suggested procedures are based on experience as of the date of publication. They are not necessarily all-inclusive nor fully adequate in every circumstance. Also, the suggestions should not be confused with nor followed in violation of applicable laws, regulation, rules or insurance requirements.

NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE IS MADE.

Appendix IV

TASK FORCE ON PRESERVATIVE TREATED WOOD
PARTICIPANTS
FEB and DEC 1991

FIRST NAME	LAST NAME	POSITION TITLE	ORGANIZATION	DEPARTMENT	ADDRESS	CITY/TOWN	PROV/ STATE	PO CODE	TELEPHONE	FAX	MTG	TF
Rose	Pettigrew	Reg Pgm Off'r - Pesticides	Agriculture Canada	Food Production/Inspect Br	4900 Yonge St, Suite 1220	Willowdale	Ont	M2N 6A6	(416) 224-3670	(416) 224-4388	ALL	
Clifford D	Ralph	Product Mgr	Agriculture Canada	Prod Mgmt Div, Pestic Dir	2323 Riverside Dr 581 Bld	Ottawa	Ont	K1A 0C6	(613) 993-4544	(613) 998-1312	FEB	
Louis	Boire	Staff Mgr Outside Tech Res	Bell Canada	Outside Plant Research Ctr	1818 Ntee Ste-Julie	Varennes	Quebec	J3X 1T1	(514) 391-4782	(514) 652-2150	FEB	
Louise	Millette	Engineer, Environment	Bell Canada	Environment	3400 De Maisonneuve W	Montreal	Quebec	H3Z 3B8	(514) 939-7904	(514) 939-7920	DEC	
Dr Hugh E	Hawthorne P.Eng	Supervising Eng	CEA Rep(Ontario Hydro)	Process Chemistry	800 Kipling Ave, KR226	Toronto	Ont	M8Z 5S4	(416) 231-4111 Ext 6403	(416) 231-9679	FEB	4
Raye	Fraser	Senior Chemist	CK (Tech Research Centre)	Ope, Space & Mat'ls	3950 Nickmore Ave	St-Laurent	Quebec	H4T 1K2	(514) 399-6869	(514) 399-6004	DEC	
Bob	Dunn		CN Rail	Technical Research Centre	6733 Mississauga Rd S 300	Mississauga	Ont	L5N 6J5	(416) 542-6610	(416) 542-7614	ALL	1
Dr Max	Grosso	Technical Mgr	Carbochem Inc		645 Gordon St	Guelph	Ont	N1G 1Y3	(519) 837-3320	(519) 837-3861	ALL	
Dr Keith	Solomon	Assoc Dir of Education	Cdn Centre for Toxicology	(Pesticides Advisory Comm)	506-75 Albert St	Ottawa	Ont	K1P 5E7	(613) 234-9456	(613) 234-1228	ALL	4
Henry	Walthert	Executive Director	Cdn Inst of Treated Wood	(CITW)		Regina	Saskatch	S4N 5Y5	(306) 721-7611	(306) 721-8128	FEB	4
David O	Kent P.Eng	Staff Consult c/o CP Rail	Clifton Assoc Ltd	CP Rail Engineering System	340 Maxwell Cres	Sorreville	Quebec	J3P 3L7	(514) 457-8255	(514) 457-2348	ALL	3
Dr Neil G	Richardson	Dir of Technology	Domtar Inc	Wood Preserving Div	Centre de recherches/Dev	Hull	Quebec	K1A 0G1	(819) 997-3715	(819) 994-7762	ALL	
Gustam	Das P.Eng	Prog Eng REEPO	Environment Canada	Industrial Prog Br 13th Fl	351 St Joseph Blvd V Hose	Hull	Quebec	K1A 1C5	(819) 997-1107	(819) 997-8697	ALL	4
Jacques	Caretta	Director of Trade	Forestry Canada	Industry, Trade & Comm Div	351 St Joseph Blvd, 21 Fl	Ottawa	Ont	K1G 3Z5	(613) 744-0963	(613) 744-0903	ALL	1
Ed E	Doyle	Research Chemist (East Div	Forintek Canada Corp	Wood Bio-Innovations Dept	800 Montreal Rd	Ottawa	Ont	K1A 0K9	(613) 952-8332	(613) 952-9536	FEB	
Dr Seah	Iyengar	Toxicologist	Health & Welfare Canada	Health Prot Br, Pestic Div	Rm 1516,Brooks, Turney's	Ottawa	Ont	K1A 0L2	(613) 952-7810	(613) 954-2486	FEB	
Dr Dieter	Riedel	Great Lakes Health Affects	Health & Welfare Canada	Envir'l Health Directorate	Turney's Pasture A203 ENC	Ottawa	Ont	K1A 0L2	(613) 957-1855	(613) 952-7536	DEC	
Steve	Wang	Toxicologist	Health & Welfare Canada	Assessm't Sect Rm2605-F25	Main Stats Bldg, Turney's	Ottawa	Ont	K1A 0L2	(613) 957-1853	(613) 952-7536	DEC	
Pam	Maloney	Evaluator	Health & Welfare Canada	Exposure Assess Rm2605-F20	Main Stats Bldg, Turney's	Ottawa	Ont	K1A 0L2	(613) 957-1853	(613) 952-7536	DEC	
Wendy	Hartimer	Engineer Scientist	Hydro Ontario	Chemical Research	800 Kipling Ave, KB138	Toronto	Ont	M8Z 5S4	(416) 231-4111 Ext 6979	(416) 231-9679	ALL	2,3
Louise	Hauda (Rep Copy	Res Scientist, Toxicology	Hydro Quebec	Chemical Research	1010 St Catherine St E	Montreal	Quebec	H2L 2K3	(514) 985-7103	(514) 985-7203		
John T	Allin	Policy Dev't Co-ordinator	MNR Ontario	Fisheries Br	99 Wellesley St W	Toronto	Ont	M7A 1W3	(416) 965-7865	(416) 324-7293	FEB	2
Geoff M	Cutten	Environmental Scientist	MOE Ont (Environment)	Hazard/Contamin' Coord Br	2 St Clair Ave W, 12th Fl	Toronto	Ont	M4V 1P5	(416) 323-5117	(416) 323-5166	ALL	2
Jack E	Weir P.Eng	Research Eng, Soc'y HPC	MTO Ont (Transportation)	R&D, Hwy Inves, Rm 331	1201 Wilson Ave Cent Bldg	Downsview	Ont	M3H 1J8	(416) 235-4699	(416) 235-4872	ALL	
Ray	Taylor P.Eng	Research Eng (Str & Wood)	MTO Ont (Transportation)	R&D, Str Off, Rm 331	1201 Wilson Ave Cent Bldg	Downsview	Ont	M3H 1J8	(416) 235-4495	(416) 235-4872	ALL	3
John	Slobodian	Environmental Planner	MTO Ont (Transportation)	Environmental Off, 2nd Flr	1201 Wilson Ave West Bldg	Downsview	Ont	M3H 1J8	(416) 235-3478	(416) 235-4922	ALL	2,3
Marcia	Weaver	Head, Water & Contaminants	MTO Ont (Transportation)	Environmental Off, 2nd Flr	1201 Wilson Ave, W Bldg	Downsview	Ont	M3H 1J8	(416) 235-3482	(416) 235-4922	DEC	
Dr Alex	Kazakov P.Eng	Sr Research Eng	MTO Ont (Transportation)	R&D, Strategic Res, Rm 331	1201 Wilson Ave, Ctl Bldg	Downsview	Ont	M3H 1J8	(416) 235-4483	(416) 235-4872	DEC	
Scott	Grove	Tech Mgr, Wood Preservat'n	Koppers Chemical Inc	(Copper Napthanate)	2301 Scranton Rd	Cleveland	Ohio	44113-4395	(216) 781-8383	(216) 781-6634	ALL	1
Russ	Smith	Project Mgr	TAC (Transp Assoc Canada)		2323 St Laurent	Ottawa	Ont	K1Z 4A6	(613) 521-4052	(613) 521-4562	FEB	
Craig	Wilson	Mgr, Tech & Env Serv	Timber Specialties Ltd		PO Box 2, 2nd Line West	Campbellville	Ont	L0P 1B0	(416) 854-2244	(416) 854-0834	FEB	2
Tom P	McGill	President	Timber Specialties Ltd		PO Box 2, 2nd Line	Campbellville	Ont	L0P 1B0	(416) 854-2244	(416) 854-0834	DEC	
Brad	Burmeister	Vice Pres	Timber Specialties Ltd	Chemical Div	PO Box 2, 2nd Line W	Campbellville	Ont	L0P 1B0	(416) 854-2244	(416) 854-0834	DEC	
Paul A.	Cooper	Assist Professor	University of Toronto	Fac Forestry, Wood Science	33 Willcocks St, Ea Ex Ct	Toronto	Ont	M5S 3B3	(416) 978-5323	(416) 978-3834	ALL	3
E John	Wilkinson	Mgr, Governmental Affairs	Vulcan Chemicals		1225 19th Street NW SU300	Washington	Dist Col	20036	(202) 293-0635	(202) 223-5979	DEC	2
Dennis	Lindsey retired	Product Mgr	Vulcan Chemicals Ltd	Organic Chemicals	PO Box 7689	Birmingham	Alabama	35253-0689	(205) 877-3507	(205) 877-3448	FEB	1